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Theory, the Greatest Tool of Reasoning

Few things are more disconcerting to most of us than to be suddenly asked to define some common word. You think you know the difference between "plant" and "animal," but try to write a definition of either one of these class terms that will pass uncriticized by a biologist.

The writer was once asked on the witness stand whether a theory is as trustworthy as a fact. He replied by asking the lawyer to define the word theory. The attorney started to do so, but was quick enough to see that he would probably make a mess of it, so he countered by saying that he was not under cross-examination himself, and that the witness could give his own definition of theory.

In his Logic, Mill distinguishes between an hypothesis and a theory. An hypothesis may be called a provisional theory, and a theory may be called an established hypothesis, according to Mill. A scientific theory is an explanation of a phenomenon. Usually the explanation consists in giving the causes of a given effect. Spencer says that we explain a previously unknown thing when we are able to show that it belongs to a known class of things; thus if a rustle is heard in the grass, we may be unable to explain it until some other sound or sight enables us to classify the cause of it. Perhaps the chirp of a bird or the sight of a bird in the place whence the rustling sound came serves to enable us to explain the rustle.

La Place formulated his celebrated "nebular hypothesis" to explain the origin of the solar universe. Several facts were explained by this hypothesis, notably the fact that all the planets revolve in the same direction around the sun, and that this direction is the same as the one in which the sun rotates about its own axis. Yet certain other facts remain unexplained by this hypothesis, notably that the moons of certain planets revolve in a retrograde or opposite direction; and that the planets have a periodic arrangement. So the nebular hypothesis has continued to be called an hypothesis and not a theory. In popular parlance, however, no distinction is made between hypothesis and theory, any explanation, however farfetched, being called a theory.

If a theory is nothing but an explanation, why do we so commonly hear disparaging remarks about theories and theorists? The answer seems to be that those who speak slightingly of theories have never stopped to define the word. Someone has pointed out that the "practical men" who are prone to decry theories are themselves stuffed with theories. Ask any practical man why so and so occurs, and he will almost invariably essay an answer; that is, he will offer his theory. Probably it will be a lamentably crude explanation, often impromptu in its conception, generally unsupported by more than one or two facts, yet it will be uttered with every mark of assurance.

Let the same practical man hear a scientific theory expounded by one who has gathered and examined all the evidence after years of study and experiment, and what is the common reaction of that practical man? "Oh, it sounds very plausible, but of course it is merely a theory."

Well, it is merely a theory that the earth revolves about the sun, acting under a theoretical force called gravitation; and that the four seasons result; and it is merely a theory that day and night are the result of the earth's rotation about an axis that no man has ever seen. And it was mere theory that the earth is round that led Columbus to undertake his celebrated voyage in 1492. So mere theory may be a very practical thing.

When you fully grasp the meaning of the word theory you see that sound theory is the very basis of sound practice. A theory merely asserts that certain effects have been produced by certain causes. The germ theory of disease was one of the most benificent theories ever propounded. Prior to that there had been disease theories galore, ranging from the "devil theory" to the theory of "disease humors" that called for frequent blood lettings.

Sound theory, then, is itself a fact, for all it asserts is a sequence of events of a given class. Most theories are either wholly or partially unsound, and that explains why the word theory conveys to most minds a sense of uncertainty. But because most theories are unsound is no reason for being antagonistic toward all theories. If such an attitude were logical, we should remain dumb because so few of us use entirely correct language. Nearly all tools are defective in some particular. Shall we speak slightingly of all tools in consequence? It will be better to busy ourselves removing the defects, and improving our skill in the use of our tools.

Theory is man's greatest reasoning tool. Let us try to speak of it with more respect and less ridicule.

H. P. Gillette

Are the Ocean "Deeps" Ancient "Sunspots"

By H. P. GILLETTE, Editor

IN previous articles I have given facts supporting the theory that the material that forms the planets was ejected from sunspots on our sun, and that similar ejections from the eight planets produced their moons. An obvious inference from this theory is that we should find evidences of the existence of ancient sunspots on our earth. The ocean "deeps" seem to furnish the answer to this inference, and possibly some of the great lake basins are also ancient sunspot areas.

A glance at the accompanying relief map shows striking likeness between the "deeps" and spots on the sun, both as to shape and as to the latitudes between which they are most numerous. Reference to ocean maps shows a similar zonal congregation of "deeps" in the Pacific Ocean. In both of these great oceans, "deeps" are most numerous north of the equator between latitudes 10 to 40 degs. Another zone of "deeps" is between latitudes 5 to 20 degs. south.

It is characteristic of sunspots on the sun that they are most numerous in certain zones, beginning a few degrees north or south of the equator and extending to latitudes of about 40 degs.; and that they are more numerous for a time in the northern hemisphere and then for a time in the southern hemisphere. It has been found that they are more numerous in areas farthest removed from certain planets; which at times causes longitudinal concentration of spots. We see the same sort of longitudinal concentration of ocean deeps. The western half of the Pacific contains many deeps; the east half contains none. In the Pacific there are two deeps lying between longitudes 155 and 170 degs. W., and they are about 90 degs. west of a large deep in the Atlantic.

The same sort of distribution of solar disturbances in latitudes 90 degs. (and also 120 degs. apart) is to be seen in a chart of solar faculae (bright areas) in Clayton's "World Weather," p. 299. Also if reference is made to photographs and maps of our moon there will be found, about 120 degs. apart, two ridges along which are frequent craters.

The lunar craters are probably frozen sunspots. It is true that they do not show concentration in certain latitudes, like sunspots on the sun and on the earth, but this is explainable because the moon's axial rotation had become almost negligible when these craters solidified. Centrifugal force is one of the reasons for latitudinal concentration of sunspots.

The Gulf of Mexico and the Caribbean Sea look like frozen sunspots, somewhat shallower than the great deeps, but still quite deep. The same is true of the Japan Sea, the Coral Sea and other areas in the Pacific.

Deep sea islands are all of igneous origin, and they are most numerous in the regions of ocean deeps; also "The deepest local depressions of the sea-bed are met with in the neighborhood of islands that have been raised by volcanic agency." In this respect there is strong resemblance to the raised rims that surround the moon's craters.

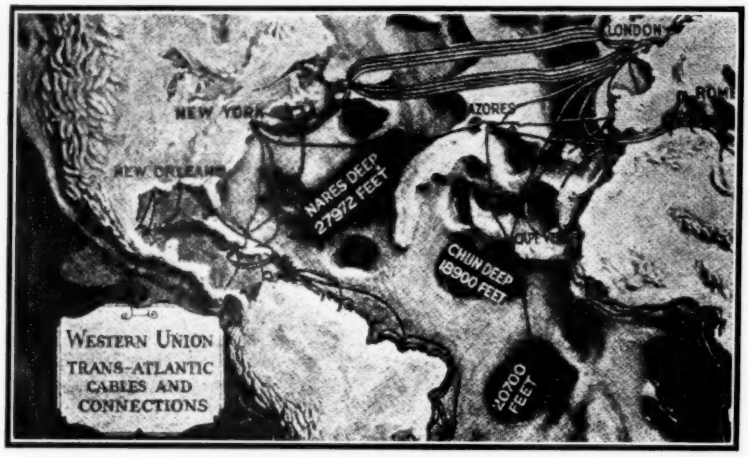
Often a large lunar crater has smaller ones near it in the arc of a circle. This finds its exact counterpart in spots on the sun.

Going still farther afield we find that the planets Mars and Jupiter show evidences of sunspots. The "canals" of Mars seem to be fissures through which molten material was forced to the surface, just as similar "rays" are seen radiating from craters in the moon. The Martian canals show less radiation from centers and more a tendency to form a network connecting focal points. These focal points are probably frozen sunspots.

The "great redspot" on Jupiter and the zonal markings on all the superior planets are apparently sunspot areas.

In seeking to unravel the riddles of nature there is no safer guide than the principle that nature uses the same general patterns, somewhat modified, in countless ways. Hence when any two phenomena resemble one another in one respect, seek to find other resemblances, reasoning from the better known to the less well known of the two. A working hypothesis then is based upon a perceived likeness between the two phenomena, and this hypothesis (or embryonic theory) announces an as yet undiscovered extension of similarity. When Galileo turned his first telescope on Jupiter he saw four moons revolving about that planet, and he was then convinced that Copernicus was right in his hypothesis that the planets revolve about the sun. Had Copernicus not already announced the heliocentric theory, it is likely that Galileo would have done so after his telescopic vision of that planetary system on a small scale, for such is the impetus of analogical reasoning.

Books on logic repeatedly warn us against the dangers of reasoning by analogy. It would have been far better for the progress of science had authors of logic stressed the fact that only by analogical reasoning are new laws of nature, obtained rationally. Men may blunder upon new laws, but when they seek by reasoning to make such discoveries there is only one royal road to victory—the road of hypothesis based on analogies. Of course this road does not constitute a discovery of a new law; but it is the only pathway to the actual discovery by a rational process. Left to chance there are countless paths that the searching mind may take, nearly all of them leading to failure. Guided by analogies there are relatively few paths, one of which is likely to lead to success.



Relief Map Showing Atlantic Deeps

Government Statistics of the Cement Industry for April

The ratio of the operations to the capacity of the American Portland cement industry during the month of April was 70 per cent, according to figures released recently by the Bureau of Mines of the Department of Commerce. During the month 13,468,000 bbl. were produced, 13,307,000 bbl. were shipped, and there were in stocks on hand at the end of the month 27,605,000 bbl. Production in April, 1928, was 4.1 per cent less, and shipments about 7.3 per cent less, than in April, 1927. Stocks at the mills were 16.7 per cent higher than a year ago.

Relining a Reservoir By the Cement Gun Method

How a Leaky Reservoir Was Tightened by Gunite

By LEWIS M. HASTINGS
City Engineer, Cambridge, Mass.

THE reservoir of the Cambridge, Mass., water works at Payson Park was built in 1894, 1895 and 1896 and was to have the double function of giving increased head or pressure on the pipes and also a good supply of water in store in case of a large fire. The reservoir occupies nearly the whole of a tract of land 11¾ acres in extent and contains, when full, about 43,000,000 gal. of water, having a surface area of 7.4 acres. The average depth of the water is 20 ft. The enclosing embankments are of earth obtained from the excavations and are lined on the inside with concrete of varying thickness.

How the Old Reservoir Was Built.—The floor is also covered with cement cocrete. A heavyn partition wall of granite is carried across the reservoir, cutting it into two equal parts or basins, each holding about 21½ million gal. of water. The inner slopes were protected by slope paving,—the portions below the old surface of the ground being paved with brick on edge laid in Portland cement. The other portion of the slopes, above the old surface of the ground, but in the embankment, was paved with split quarry-granite blocks laid on a bed of cracked stone. These embankments also contain a core wall of masonry connecting with the inner slope paving of brick, already referred to. The reservoir was commenced in 1894 and partly constructed by a contractor. The work performed by him was so poor and unsatisfactory that in 1895 work was stopped by the water board on recommendation of the engineer, and the reservoir was finished by using day labor and materials bought by the city. The reservoir was finished in 1896 and water put in it that year.

Both basins leaked so badly that it was not possible to put more than 12 or 13 ft. of water in them without starting an amount of leakage which flooded nearby cellars and caused protests from the owners of the property. Several attempts were made to discover just where the larger leaks were, but it was found impossible to do this without tearing down more or less of the embankments and their linings. As this leakage water was not lost but was returned by the under drainage system to Fresh Pond, the financial loss was not a large one at first, the daily amount escaping from the reservoir being about 20,000 gallons. Gradually,

Shooting Gunite on Reservoir Floor. Partition Wall and 40 in. Inlet Pipe in Background

however, the leakage seemed to increase, and for the year 1926 it averaged about 500,000 gal. daily. This, together with the increased cost of the water due to filtering, and the desirability from an insurance standpoint of increasing the pressure and the reservoir storage by keeping the reservoir full, led the water board to a decision to reline the reservoir so that it might, with safety, be kept full and without excessive loss from leakage. This matter was under consideration by the water board for nearly ten years.

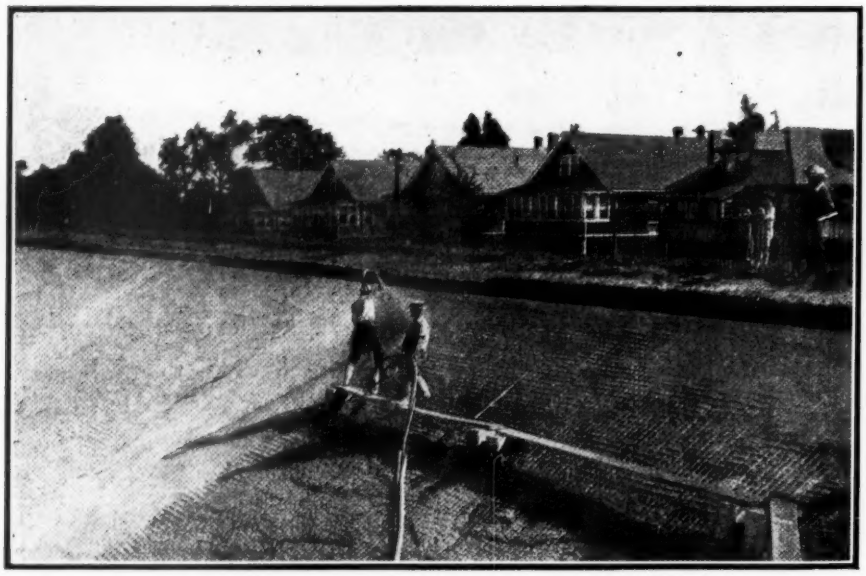
The New Reinforced Gunite Lining.—Several trips were made to the cities where similar work had been carried out, and the water board finally concluded that, on the whole, covering the entire inner surfaces of the two basins with a lining not less than 2 in. thick and composed of the best American Portland-cement mortar, applied in the form of and known as "reinforced gunite," would be the most satisfactory and durable under the conditions existing in this reservoir. When this decision was reached, plans and specifications were immediately prepared, the work put on the market, and the contract for performing the required work was executed. This work is now substantially completed and the reservoir is now in use and full to the top.

It is my purpose to briefly describe here some of the principal features of the work as carried out. The lining was to be of gunite not less than 2 in. thick at any point and reinforced in the center with wire mesh. This mesh was of galvanized No. 5 steel wire spaced 4 in. apart in both directions, electrically welded and weighing about 71 lb. per 100 sq. ft. In order that this mesh might be kept in the center of the gunite lining, the shooter's helper, with a stick having a bent iron in one end, lifted the mesh to the required height and the gunite was quickly shot in.

Several Types of Base for Gunite Lining.—The base upon which this gunite lining was to be placed was of several general types and required different types of anchors to hold the reinforcement in place.

1. Concrete-Slab Floor Base: This base was fairly true in surface and the reinforcing mesh was held in place by ¾-in. anchor bolts 3 ft. apart in both directions. The conditions on the brick-paved slopes were quite similar.

2. Granite-Paved Slopes: Here the surface was quite irregular, with many openings between the stone blocks of irregular shape. The anchors were of ¾-in. galvanized-iron lag screws inserted between the stones. The openings between the stones were filled or choked up with the gunite as it was "shot" on to the paving. The average thickness here was over the required 2 in.



Shooting Gunite on Slope Paving. Note the Wire Mesh in Place

3. Sides of the Partition Wall. These sides were nearly vertical and had a rough "quarry face" exposure. The ⅜-in. galvanized-iron expansion anchor-bolts were inserted in holes drilled in the wall and the mesh hung from them. Here also the average thickness of the lining was much more than 2 in.

Requirements for the Gunite.—The gunite was specified to consist of 1 part Portland cement of any one of six named brands of American Portland cement, and 2½ parts of sand; the cement and the sand to be mixed dry in the proper portions, then placed in the "gun" and the water added as required at the nozzle where an air pressure of not less than 35 lb. per sq. in. was to be maintained. It was found very necessary to keep this air pressure up, for if it was lowered, the velocity of the jet was reduced, and choking and irregular flow of the materials followed. The mixing of the sand and cement was done by a mechanical mixer of an ingenious type, outside of the reservoir, carried by a belt conveyor to the top of the embankment, there screened to break up the lumps and eliminate all coarse sand and other particles, then chuted to the bottom of the reservoir inside, where small auto trucks or "buggies" carried the mixture to "guns" placed on the floor, where the air pressure was raised to about 50 or more pounds. This forced the materials through lines of hose to the nozzle where the operator or "nozzle man" added the water as required to the dry mixture and sprayed or "shot" the mixture with a circular motion onto the prepared surface to be covered. Usually four of these guns were operating at the same time.

The spraying or "shooting," as it is called, requires considerable skill and practice in order to produce good, smooth work of an even thickness and without sand pockets, lumpy bunches, rigod over-laps, or other defects.

How Specified Depth of Gunite Was Determined.—At first it was found difficult to procure an even thickness on a smooth base. The temptation to run under the stipulated thickness was very great and was often hard to detect. A very simple device proved very useful in this case. It was a stick about 4 ft. long, in one end of which a prod or needle was inserted so as to project just 2 in. from the end of the stick. Any question of the depth of the gunite being applied was quickly settled by the inspector "needleing" it as required, before set had taken place. The amount of "rebound" or loose material and coarse sand not attached in the "shooting" process was quite large, especially so on the vertical surfaces. In "shooting" the partition wall, it was estimated that 20 to 25 per cent of the material was loosened and fell to the bottom as "rebound." This material had to be carried out of the reservoir, transferred over the bank to the street level and, although of excellent stock, was given to the town of Belmont for use as filling.

The sand used for the gunite came from a bank in the town of Belmont and gave some excellent tests for cleanness and lack of iron or acid. Combined in the usual proportions with cement, it gave results better than the "Standard" or "Ottawa" sands on 28-day tests, when mixed in the usual 1:3 proportions. Tests for fineness showed that a somewhat less amount of finer gains was present in this sand than was found in some other sands. While this might tend to make the gunite less dense than some other sands with more fine grains and so increase its permeability, it was thought that its other good qualities would outweigh those of the other sands offered for use. It is expected that even if the gunite does not show a high degree of impermeability at the first, that this in time may be decidedly improved by silting up of the voids in the gunite, especially in the bottom portions of the lining under considerable water pressure, while the upper portions of the lining will tend to be sealed with the water growths, algæ, etc., of a gelatinous nature, always found at shallow depths. The walls and slope paving of this reservoir were found thoroughly coated at and for some distance below the water line with growths of this nature, which were quite difficult to remove.

The floor of the southerly basin was originally covered with a 6-in. layer of natural cement concrete, part of which was in very poor condition, Before the gunite was placed in this basin, the entire floor was covered with a 6-in. layer of Portland cement concrete. There were approximately 13,800 sq. yd. of 6-in. concrete on this floor. Upon this concrete the 2-in. gunite lining was placed. The total surface area covered by the gunite was about 374,283 sq. ft., or 8.4 acres.

Amount of Cement Required for the Gunite.—Perhaps some figures relating to the amount of cement required for gunite in the different situations may be of interest. It was found on this work that—

One barrel of cement was required on the floors and brick slopes to make gunite to cover 50 sq. ft. of surface.

One barrel of cement was required on the dividing wall to make gunite to cover 38 sq. ft. of surface.

One barrel of cement was required on the stone slope-paving to make gunite to cover 34.8 sq. ft. of surface.

Unit Prices.—The contract lump-sum price for doing the entire work was $131,576. As the monthly payments were based on unit prices of the work actually performed, the following scale of unit prices which would produce the lump-sum price, were adopted and were not objected to by the contractor, so they were thought not to be very far out of the way.

6-in. concrete floor at $2.25 per sq. yd., or $13.50 per cu. yd. of concrete.
2-in. gunite on floor at $2.15 per sq. yd.
2-in. or more gunite on slopes at $2.45 per sq. yd.
2-in. or more gunite on partition wall at $3.15 per sq. yd.
3-in. pipe drain of galvanized iron at $2.65 per ft.
Vitrified underdrain pipe at $5.00 per ft.
Elastic joints at $2.00 per ft.

Acknowledgment.—The above is an abstract of a paper presented by Mr. Hastings, Jan. 11, before the New England Water Works Association.

Water Rates in 1876 and 1927.—The present minimum metered house rate at Danvers, Mass., is just one-half the rate in 1927, according to the recently issued annual report of Roger W. Esty, superintendent of water works. The minimum household rates with kitchen faucet and bathroom from 1876 to 1901 were $16; from 1901 to 1923, $10.50; and 1923 to 1927, $12.50. These are fixture rates. The 1927 rate by meter is $8.

Financing the Operation of Sewage Treatment Plants

Ohio Experiences Told in Paper at Ohio Conference on Sewage Treatment

By F. H. WARING
Chief Engineer, Ohio Department of Health

WHETHER a sewage treatment plant is a success or a failure depends in greatest measure upon whether or not the plant is operated in skilled fashion.

Provision for proper operation of the sewage works by a municipality usually involves two main considerations: personnel and finance. These items are closely related, because without proper financial provisions technical supervision and skilled operation are impossible. In some states (Pennsylvania and Ohio) municipalities are confined within certain statutory limits regarding expenditures for construction of works and for ordinary operating funds. In the majority of states these financial restrictions are not statutory. In all states, however, there exists the need of convincing local authorities of the advisability and necessity of providing funds for adequate operation of sewage treatment works.

The degree of financial provision for operation, then, usually dictates the degree to which the sewage treatment is scientifically operated. In proportion to the budget provisions the personnel will vary all the way from regularly employed technically trained and experienced men to the very non-technical or laborer class of operator, or even to no regularly employed full time operator.

Ohio Sewer Rental Law.—In 1923 a law was passed with particular reference to the financing of the operation of the sewage treatment works. This statute is known locally as the sewer rental law. The purpose of this law is to permit municipalities to assess and collect charges for the use of sewers and to provide for the proper maintenance, operation and control of sewerage systems and sewage disposal works. The law is intended to place the sewerage department of the municipality upon much the same basis as the water department is placed; in other words the department will be operated as a utility and placed upon a self-supporting basis by equitable charges for sewerage and sewage disposal service.

Past Experiences in Sewage Works Operation and Control.—Ohio has about 75 sewage treatment plants serving municipalities, these plants differing widely in size and type including devices of almost every description. In past years efforts to obtain satisfactory operation of sewage treatment works in Ohio have not been entirely successful; probably less than 10 per cent of the plants have been operated under technical supervision and probably less than 20 per cent have been giving satisfactory service to protect the streams from nuisance and undue pollution conditions.

A survey of the stream pollution conditions within the state was begun about five or six years ago and one of the first important conclusions reached was the reason for failure of sewage treatment works. It was found that the municipalities neglected the operation of the works largely on account of inability to finance their operation out of current revenues. Ohio laws limit municipalities very makedly in the amount of money that may be raised by taxation methods with the result that all activities have been cramped very materially in the last decade. Various efforts have been made to enact new laws on the taxation question in order that the municipalities might have more money to spend for improvements and for operation of the various departmental activities of the corporation. It was invariably the rule that sewerage service and sewage treatment and disposal items were the last to be taken care of. This remained true even though the cities might be forced to pay damages for conditions created by the neglect of the sewage treatment works, because damages were a preferred charge against the municipality and did not come within the ordinary bond and tax limitations.

Policy Determined Upon by Administrative Authorities.—During the past few years the Ohio Department of Health has adopted the policy of refusing to approve plans for new sewage treatment works unless the department could be reasonably well assured that sufficient funds would be provided for the correct maintenance and operation of such works. It is somewhat surprising but nevertheless true that municipalities wanted to build plants without knowing exactly where the funds would be procured to operate them. In large measure the reason was to hold off damage claims and embarrassing injunction suits.

It was observed that an order of the department regarding the correction of improper operation might be nullified if the municipality did not have sufficient funds to operate under the order. It was for this reason that the department requested the passage of the sewer rental law enacted in 1923.

Experiences With the Sewer Rental Law.—Since the statutes have been amended to provide for special revenues for sewerage departments several municipalities have passed ordinances fixing charges for sewer service which will make possible the proper financing of the sewage treatment works. The revenue required in the case of the ordinary village or small city may easily be secured from a flat rate charge and it appears that about $4 to $5 per year per house connection will bring in enough money to take care of the operation charges. Some municipalities have determined upon a graduated scale of charges based upon the water consumption as a measure of sewage flow. In those instances where industries may be provided with private water supplies, estimates of sanitary and industrial sewage may be made. Five municipalities have had in effect such ordinances for a year or more, and two have recently adopted such ordinances. Fifteen municipalities are contemplating sewer rental ordinances or have taken the preliminary steps to place the ordinances on the local statute books. The seven municipalities now with ordinances are Andover (921), Bellefontaine (9,336), Brewster (928), Delaware (8,576), East Palestine (5,750), Euclid (3,363), Oxford (2,146).* The populations of these seven communities range from 921 to 9,336. The fifteen contemplating sewer rental ordinances are Akron (208,435), Canton (87,091), Centerburg (775), Chardon (1,566), Columbus (237,031), Cleveland (796,841), Dayton (152,559), Fostoria (9,987), Galion (7,374), Granville (1,440), Lebanon (3,396), Leetonia (2,688), Marysville (3,635), Sebring (3,541), and Xenia (9,110).* The populations represented by these fifteen communities range from 775 to 796,841. In the foregoing list of fifteen municipalities now contemplating rental ordinances, six represent municipalities where new plants are under construction or just completed; two where new plants are being proposed to take the

*Sewer rental ordinances for the municipalities of Chardon, Dayton and Granville were also in effect in January, 1928.

place of existing real old ones; and the remaining seven have just plantes that have been constructed within the past few years.

Attitude of Municipalities Regarding Technical Operation of the Plants.—It is pleasing to note that in the new works now being projected in the state where the matter of skilled operation has been broachd to the municipal authorities as a condition upon the construction of the works that the municipality is accepting this important item without question. It seems that most of the municipalities are beginning to realize the necessity for skilled operation and supervision of the plant which can only be obtained by properly educated men.

Comparatively little difficulty is being experienced in convincing large cities of the advisability of providing technical talent to direct the operation of the sewage treatment works. Those in authority at these large cities readily understand the wisdom of protecting a huge investment; and they realize that if the city's interests downstream from the treatment plant are to be protected properly, scientific management and a technical record of the operation are imperative. The most recent example of this attitude is the City of Canton, which has made provision for a salary of $4,000 for a high grade, technically trained sewage treatment superintendent.

Small cities are not so easily convinced that provision should be made for technical control of the operation. The salary to be paid for the technical talent seems large in proportion to what is paid the mayor, director of public service or other city officers. Unless the duties of other positions such as water purification management, superintendent of water works, city engineer of the like are added, but few small cities will voluntarily pay the salary required. Two exceptions are to be noted: (1) In the case where the city is constantly being sued by property owners below the works and forced to defend itself against damage claims; (2) in the case where previous neglect or improper operation resulted in ruin of the works, and entire replacement has become necessary within a comparatively short time.

There are some special examples of a keen incentive to operate the sewage treatment works in scientific manner. For instance, the City of Portsmouth, O., which has a sewage treatment plant serving a suburban portion of the city and located 1½ miles upstream on Ohio River above the city's water works intake; and the City of Cleveland, which takes its water supply far out from the shore of Lake Erie, and maintains bathing beaches along the shore, but into which waters not far from the shore are discharged the sewage effluents.

Generally speaking, however, the incentive for high grade talent in the operation of sewage treatment plants is lacking naturally. The proper municipal attitude can be cultivated, though. A little effort with the city officials may keep alive the very interest which caused the plant to be constructed. It is even sometimes a good plan to hold back a community in its desire to build such works until a proper appreciation is held for the necessity of technical control of operation and due provision is made therefor. One thing is certain: wherever technical operation is once provided, constant publicity by the plant operator is essential or the financial support making possible such operation may be withdrawn. With careful and studied effort on the part of the operator a proper sentiment and support can be developed.

What Has Been Done to Skilled Supervision.—The Ohio Department of Health is making concentrated efforts upon both large and small municipalities to provide better skilled operaion and supervision. It is our policy to see that all new works make provision for proper supervision of operation and to encourage such supervision of existing works as fast as possible. Recent accomplishments in this direction are the arrangements made by the small city of Xenia (9,110) to have part time technical supervision by the chemist-in-charge of the Columbus sewage treatment works; and by the City of Delaware (8,576), which has contracted jointly with the City of Marion (27,891) in the employment of a trained technical operator.

In the case of Xenia the part time supervision costs about $600 per year, or $50 per month; while in the case of Delaware the joint contract arrangement costs Delaware $900 per year, or $75 per month. Xenia is about 50 miles from Columbus; Delaware, however, is only 20 miles from Marion. Therefore it follows naturally that Delaware is in position to profit more than Xenia in the foregoing arrangements and accordingly can afford to pay a trifle more for the increased time of skilled supervision.

The system which is being attempted is quite similar to that in vogue regarding the operation of water treatment plants in this state; namely, all cities of size, say over 15,000 people, make provision for a full-time daily skilled operator who is to reside in the community; and for smaller cities and villages part-time supervision by the trained man from the nearby larger city having proper technical supervision. In some instances it has been possible to combine the water treatment and sewage treatment technical work in the hands of one operator, although it is realized that this endeavor will be limited to the smaller municipalities where the time required at these works will be proportionately less. In some cases a supervisor has been obtained from a firm specializing in providing such service. The following municipalities now have provided for full time technical supervision of sewage treatment works: Alliance (21,603), Barnesville (4,865), Canton (87,091), Cleveland (796,841), Columbus (237,031), Marion (27,891), Medina (3,430), and Portsmouth (33,011). The populations of these eight municipalities range from 3,430 to 796,841. The following plants now have part-time technical supervision of the sewage treatment works: Delaware (8,756), Euclid (3,363), Leetonia (2,688), Lodi (1,240), Louisville (2,008, Oberlin (4,236),* Sebring (3,541), and Xenia (9,110).* The populations of these municipalities range from 1,240 to 9,110. It is to be borne in mind that the effort of this department to obtain the high grade skilled supervision and operation of the treatment works has only been carried on intensively for about a little over a year. There has been a delay necessary until financial provisions could be prepared and adopted in the municipalities for the necessary revenues to carry on proper operation.

Conclusion.—In conclusion the writer wishes to offer the opinion that the failure for proper sewage works operation in the past has been due, at least in Ohio, to two main reasons: (1) There has been a lack of proper education on the part of the state toward the municipalities having the sewage works problem. This has been due largely to insufficient personnel within the department although this has been remedied in Ohio within the last few years. (2) There has been a lack of appreciation on the part of municipalities toward properly financing the treatment and disposal of sewage; in addition there have existed peculiar financial limitations of municipalities in this state which have prevented them from providing sufficient funds, even where willingness was expressed.

*Part time technical supervision for Burton (592), Centerburg (775), Granville (1,440) and Salem (10,305), was also in effect in January, 1928.

Oregon Great Power State.—The potential water-power resources of Oregon amount to 3,665,000 h.p. as estimated from the stream flow available 90 per cent of the time, or 5,890,000 h.p. as estimated from the flow for 50 per cent of the time, if storage is provided in feasible reservoir sites, according to a statement made public by the Department of the Interior based on field work and studies of the Geological Survey. River surveys have been made and maps published by the Geological Survey covering 1,674 miles of rivers in Oregon. The river surveys included a number of reservoir sites, and in addition 47 dam sites were surveyed on a large scale.

Grand Haven, Michigan, Gets New Water Works

Filtration Plant, Pumping Station, Increased Elevated Storage and Intake Planned for the Resort City

GRAND HAVEN, MICH. is typical of a number of the cities on the easterly shore of Lake Michigan in that it is located on an estuary of one of the numerous rivers draining into the lake on its easterly side and in that it is a center for a number of summer colonies located on the Lake Michigan shore and nearby smaller lakes. Grand Haven is having a rapid growth due to many active industries and this growth now requires an expansion and modernization of its water works.

Prior to undertaking the present improvement the city obtained its water supply from groups of wells. One of these groups, and the oldest, known as the Wiley wells, was located in the easterly part of the city and obtained its supply from extensive but rather shallow gravel deposits. The Wiley wells proving insufficient, another group of wells was established on Lake Michigan shore in the westerly part of the city. This group comprised one large central open well surrounded by a number of tubular wells. The system was later supplemented by an infiltration gallery of tile pipe. The third group comprises tubular wells in the vicinity of the municipal electric power plant on the south bank of the Grand River about half a mile from the lake shore. In 1923 and 1924 a study of the water supply requirements and the water supply resources of Grand Haven was made as a preliminary to deciding upon the best mode of developing an adequate supply of water satisfactory with reference to sanitary quality and mineral content.

Supply Problematical.—On the basis of available knowledge of the existing wells supplemented by some special tests at the sites of the Wiley wells it was concluded that a well water supply might be developed from known sources at somewhat less cost than a lake supply, but the adequacy of such a supply would remain problematical. The conclusion was reached that it would be inadvisable to develop a well supply without further explorations of ground water resources which it was estimated could not be undertaken for less than about $10,000. Taking this into account the development of a well supply would

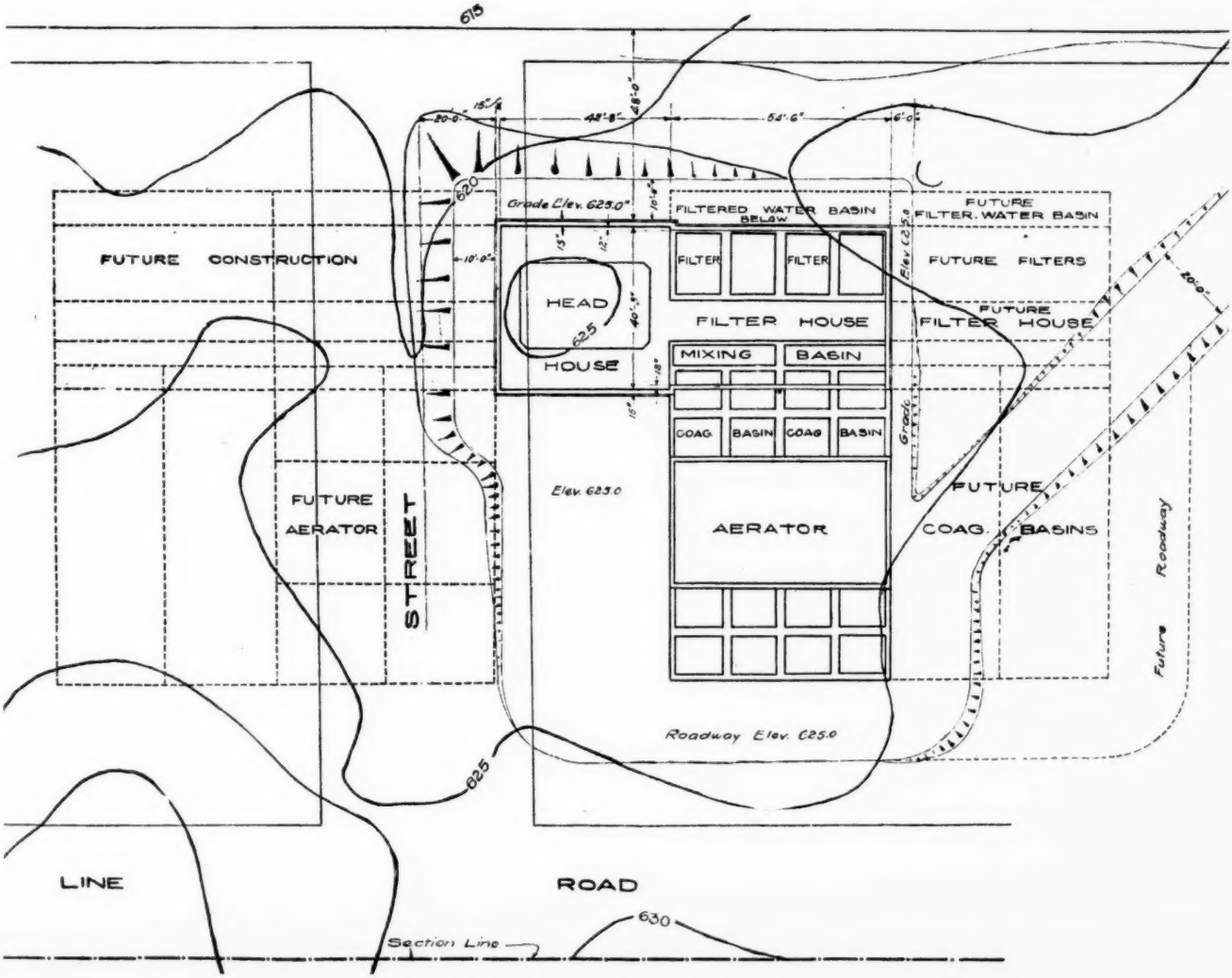


Fig. 1—General Layout of the Filter Plant Showing Present Work and Arrangements for Expansion

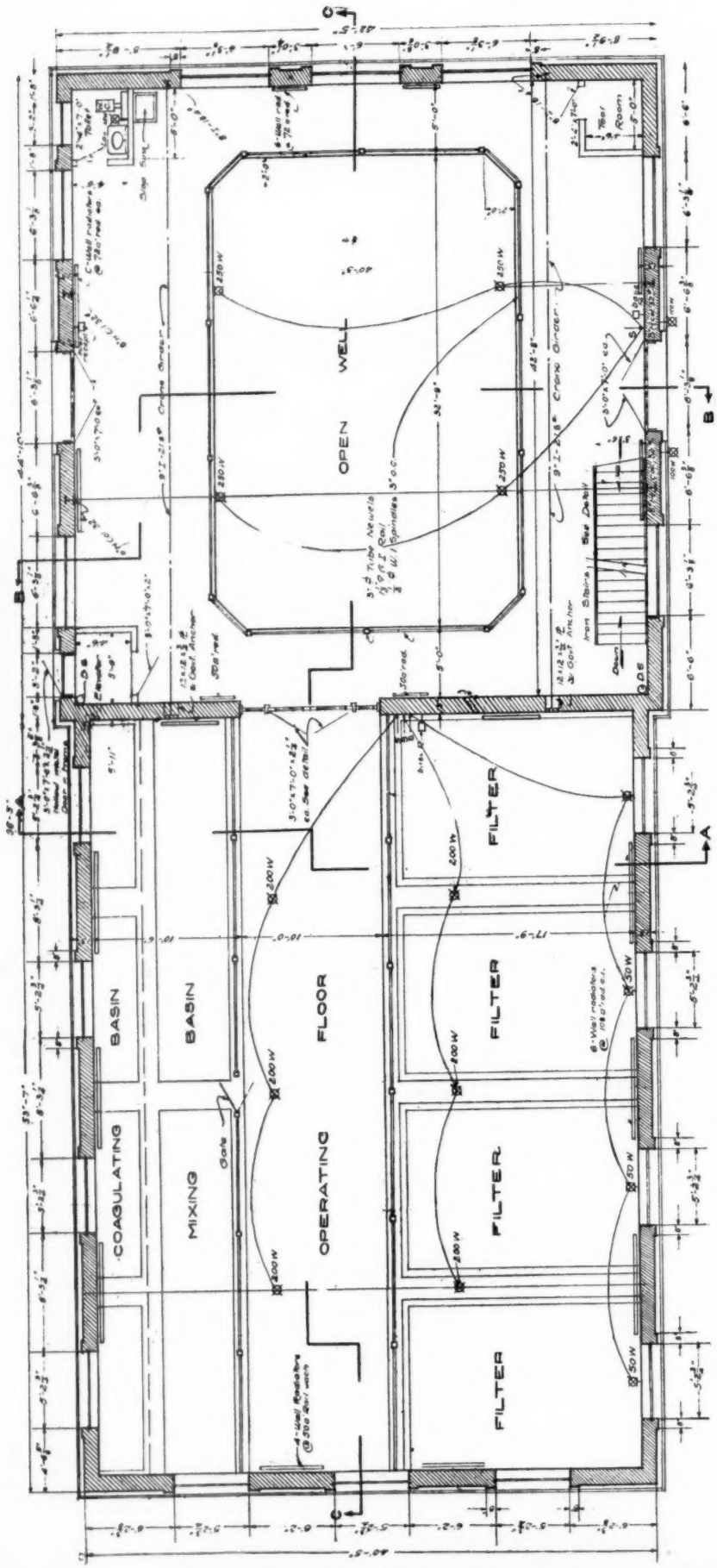


Fig. 2—Plan of Main Building Showing Head House

cost approximately the same as the development of a surface supply, and would still be a gamble to the extent of $10,000

Adopted Lake Supply.—Accordingly the city decided in favor of the ultimate development of a lake water supply which is practically unlimited, and which can meet any increased growth by successive development of the works.

Population.—Grand Haven in 1920 had a population of 7,205 according to the U. S. Census figures. A forecast was prepared of probable future growth based upon past growth, increase in the number of water services, school enumeration, the tendency of growth of other cities of similar type, etc. This forecast indicated a population of 12,200 in 1940 and 17,500 in 1960. The design of the proposed water supply improvements was predicated upon these figures. Elements readily enlarged or readily extended were predicated on the population of 1940. Elements not readily extended were predicated upon the population of 1960. In connection with Grand Haven special attention had to be given to large summer population a factor, which determines the capacity of necessary works. The average monthly water demand in the summer season reaches 160 per cent of the average for the year, whereas the winter demand is but 75 per cent of the average for the year. In addition to the population it was also necessary to give careful consideration to the probable future per capita water consumption. This was based upon a careful analysis of per capita water consumption in Grand Haven in the past and also on collateral data from other places. In designing the proposed works it was assumed that the average per capita consumption will be 100 gal. per day; that the per capita consumption during the maximum month based on permanent population will be 160 gal. per day; and the per capita consumption during a maximum day based on permanent population will be 256 gal. On the basis of permanent population estimated for 1940 namely 12,200 the average daily consumption will be 1,220,000, the daily consumption during a maximum month will be 1,950,000 and the maximum daily consumption will be 3,120,000.

Design Basis.—On the basis of the various consideration above enumerated it was believed that the works for immediate installation should be based on the following capacities:

Pumping equipment 3,500,000 gal. per day, divided into 3 units of 2 million, 1½ million and 1 million gal. per day respectively.

Filter plant capacity, normal rate 2,000,000 gal. per day. Maximum rate 3,00,000 gal. per day.

Total storage including elevated storage and storage in the clear water reservoir at filter plant, 1,600,000 gal.

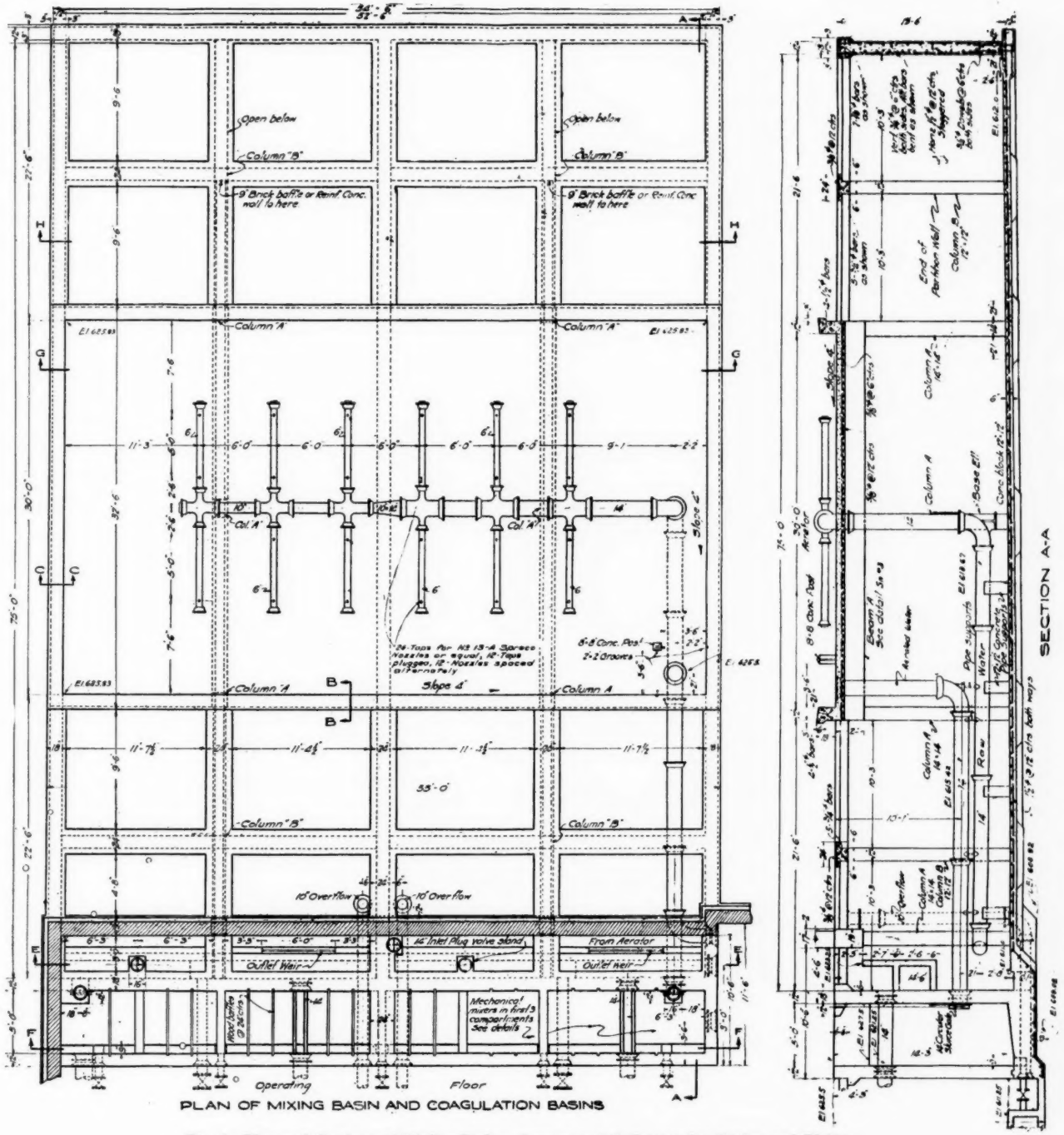


Fig. 3—Plan and Sections of Mixing Basins, Aerator and Sedimentation Basins and Piping

Lake intake—maximum capacity, 6,000,000 gal. per day.

The pumping equipment, is relatively small on account of the large elevated storage namely 1,500,000 which is amply sufficient to neutralize the differential between a uniform rate of filtration and pumpage and the hourly fluctuations even on a day of maximum demand. Hence the high lift pumps need operate only at the maximum rate of operation of the filter plant.

Owing to lack of funds it has not been practicable to include the lake intake with the present improvement. Accordingly a temporary river intake has been constructed from which water will be pumped by existing pumping equipment at the municipal electric power plant, into the new filter plant at an elevation of approximately 45 ft. above the river.

Distribution.—The improvement involves practically no modification in the existing distribution system. The main pipe line from the existing pumps in the municipal electric power plant to the elevated tanks on one of the high sand dunes in the vicinity will be cut. The lower portion will be used for the discharge of the low lift pumps to the filter plant, and the upper portion will be used for the main discharge from the pumps at the new pumping station built in conjunction with the filter plant.

Filter Plant.—The filter plant embodies latest developments in the application of filtration to lake waters. The installation is also interesting in that it has been carefully planned for ready enlargement to four times the present capacity, or eight million gal. The filter plant comprises (1) dry feed chemical equipment (2) a spray nozzle aerator (3) a reaction chamber equipped with stirring devices and baffles (4) two sedimentation basins (5) four filters each having a nominal capacity of 500,000 gal. per day and (6) a clear water reservoir of 100,000

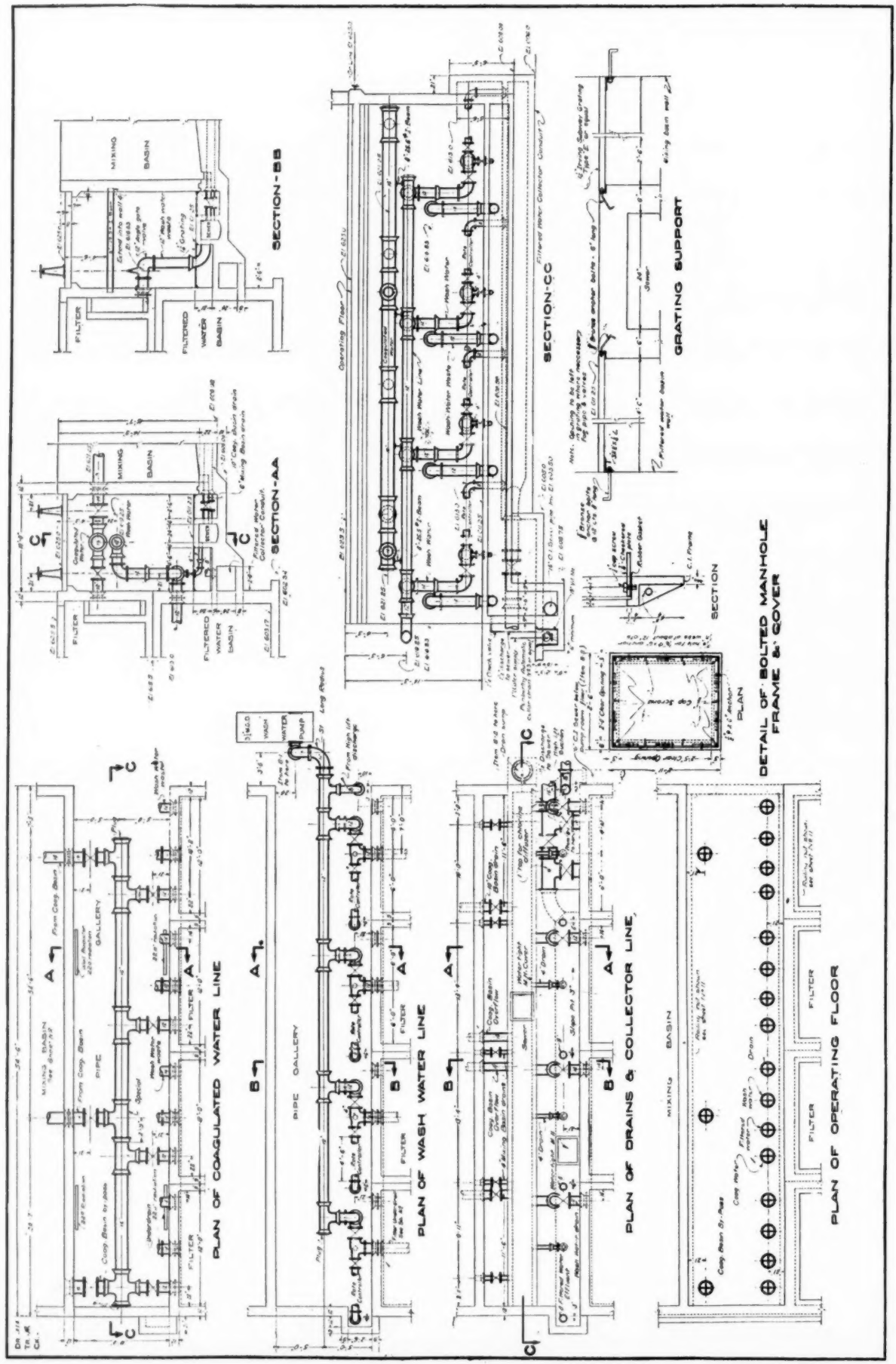
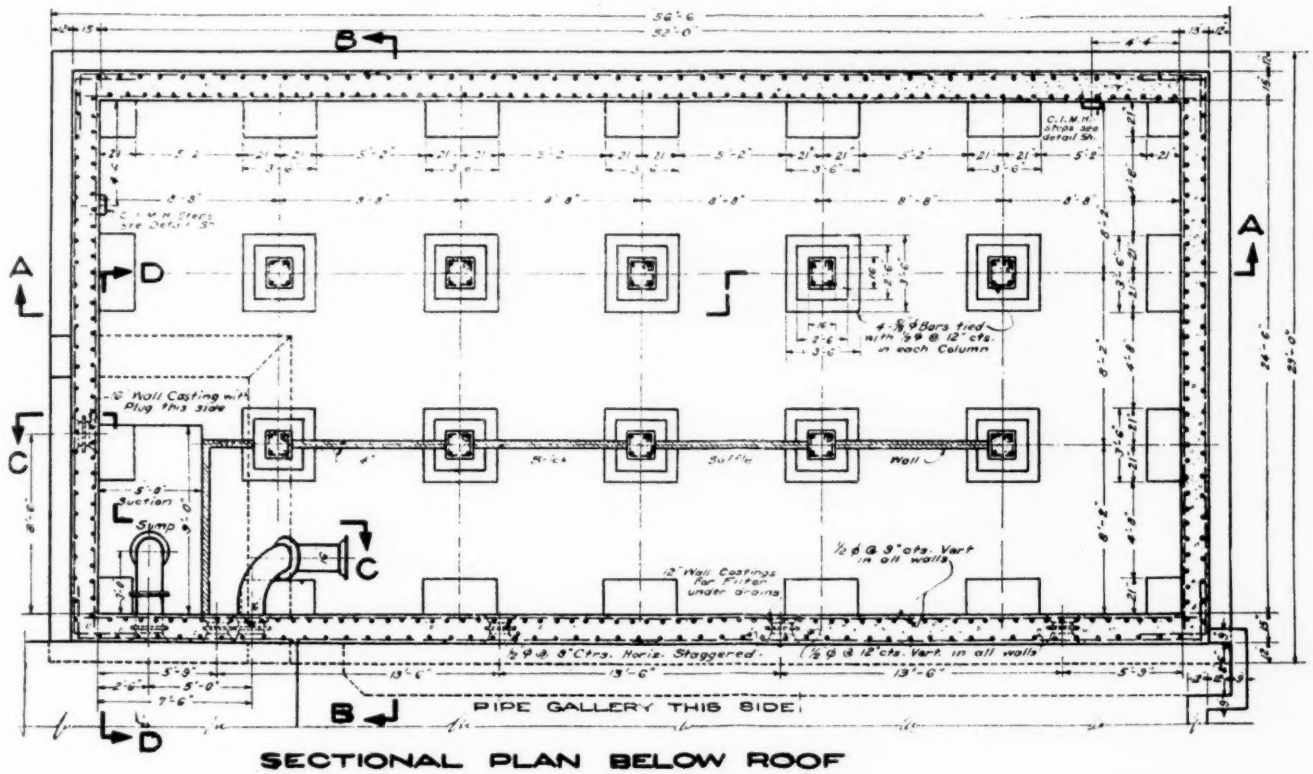


Fig. 5—Diagram Showing Filter Plant Piping



gal. capacity, located under and supporting the filter units.

The filters have been built adjoining the pumping station and head house. Special care has been exercised to secure an abundance of daylight in all parts of the works, and ready accessibility to valves, piping and pumps for inspection and repair. Special attention has also been given to artificial lighting so that every portion of the works may be brilliantly illuminated at night. Special lighting devices are provided for submergence in the water at various points to observe conditions of flocculation. Based on the nominal capacity of the plant, namely two million gallons per day, the reaction chamber has a retention period of 15 minutes, the sedimentation basins have a retention chamber of 4 hours, and the filters operate at a rate of 2 gal. per square foot per minute.

Fig. 4—Plan and Section and Filtered Water Basins

Reaction Chambers.—In the reaction chambers the water with applied chemical receives six minutes of controlled mixing by means of adjustable speed stirring devices following which it continues to be gently mixed by under and over baffles. The plant is so arranged that water may be bypassed directly from the reaction chambers to the filters, or it may be passed through the sedimentation basins in series or in parallel. Provisions is also made for bypassing the reaction chamber.

The main structure of the plant, including pump pit and all portions of the filter plant proper, is built of reinforced concrete. The superstructure is of red tapestry brick laid with wide joints. Careful attention has been given to architectural effect both inside and outside, not only with reference to the immediate installation, but with reference to the ultimate installation.

Compact Arrangement.—A very compact arrangement has been secured by placing the reaction chamber and sedimentation basins in a group on one side of an operating gallery and the filters on the opposite side so that practically every valve that requires frequent operation in connection with the purification of the water can be reached within a few steps. The chlorinating machines are also placed on the operating floor thus being readily accessible to the filter attendant. Arrangements have been made to permit of pre-chlorination of the raw water and chlorination of the filtered effluent. The latter takes place at the point where the filtered water conduit from the filters enters the clear water reservoir. The water must pass twice the entire length of the clear water reservoir around the end of a baffle before reaching the suctions of the high lift pumps.

Cost of System.—The cost of the new filter plant and pumping station is $91,500, divided as follows:

Concrete work and superstructure	$57,600
Filter piping and filter equipment	24,900
Pumping and electrical equipment about	9,000
Total	$91,500

The estimated cost of the filter plant alone is $35,000 per million gallons daily capacity. The total estimated operating cost is $22,200 per year, equivalent to about 5½ ct. per 1,000 gal. This figure is exclusive of fixed charges.

The new works are now nearing completion and should be placed in operating during the early summer of 1928. The preliminary report, and plans and specifications for the proposed works were prepared by Messrs. Pearse, Greeley & Hansen, Hydraulic and Sanitary Engineers of Chicago. The construction work is being carried out under the supervision of Mr. Paul R. Taylor, City Manager of Grand Haven. The contractor for concrete construction and superstructure is Mr. G. E. Tillman of Centarlia, Ill. The contractor for filter piping and filter equipment is the Roberts Filter Mfg. Co. of Darby, Pa.

Test for Phenolic Tastes and Odors in Water After Chlorination

A meeting was held in Pittsburgh, Pa., Feb. 6, 1928, at which were present representatives of the Pennsylvania State department of health, the Ohio State department of health, the Kentucky State board of health, the Carnegie Steel Co., the Youngstown Sheet & Tube Co., the Republic Iron & Steel Co., the Jones & Laughlin Steel Corporation, the Bethlehem Steel Co., the United Gas Improvement Co., and the Koppers Co. W. L. Stevenson, chief engineer of the Pennsylvania State department of health, chairman of the meeting, appointed a committee to consider the test for phenolic tastes and odors in water after chlorination, proposed by J. W. Ellms, of Cleveland, O., and report their opinion. The committee as appointed consists of F. W. Sperr, Jr., director of research, the Koppers Co.; W. H. Fulweiler, chemical engineer, the United Gas Improvement Co.; F. E. Daniels, chief industrial waste section, Pennsylvania department of health; and O. O. Malleis, chief chemist, the Koppers Co.

The April 13 issue of Public Health Reports contains the following statement of the work of the committee:

The committee has considered the method as presented and is of the opinion that, while in principle the method may be satisfactory for water works practice, it should be substantially modified to render it generally applicable. It is believed that, in general, a method of this sort should embody the principle of systematic dilutions with a test of each dilution, so that quantitative results can be secured. On this basis the committee has therefore drawn up a tentative method which is herewith submitted, not as final and binding, but for the purpose of inviting trial and comment. It is hoped that this method will be thoroughly examined and tried by all who are interested in the subject, and the committee would appreciae having reports of the results obtained, together with any suggestions for modification or improvement that may be considered necessary.

The tentative method proposed by the committee is as follows:

1. This test is designed as a measure of the so-called phenolic tastes and odors in water after chlorination.

2. Take 500 c. c. of the material under examination, acidulate with sulphuric acid until acid to litmus, and distill off 250 c. c. Catch the distillate in a 500 c. c. volumetric flash, make up to mark with distilled water and dilute as follows: 1 to 10, 1 to 100; 1 to 1,000, etc., preparing as many dilutions as may be necessary.

3. Take 200 c. c. of the distillate in the volumetric flask after making up to mark (this representing the original material undiluted) and a like amount of each successive dilution. Treat with a slight excess of chlorine water (a total of 0.3 p. p. m. of chlorine is usually sufficient). Let the sample stand for 15 minutes and then boil until excess of chlorine is removed as evidenced by test with orthotolidine.

Make the odor test by smelling the hot liquid. Make the taste test after the liquid is cooled. In the taste test, swallowing a small quanity of the liquid is the best method for revealing the presence of taste-producing substances.

4. Results shall be expressed as the lowest dilution in which the taste and the odor are negative.

Communications relative to the method should be addressed to F. W. Speer, Jr., Mellon Institute, Pittsburgh, Pa.

Forestry Work by the Water Board of New Bedford, Mass.

During 1927 the Water Board of New Bedford, Mass., carried on its forestry work as usual, according to the annual report of the board that year, besides a great deal of cleaning up dead wood, etc., 15,000 spruce 4-year transplants, purchased from the State Forestry Department were planted, and about the same number of pine have been transplanted from our own property. This work greatly improves the watershed and in time will produce a valuable crop of timber.

Five small brush and grass fires which started on the property or property adjoining were promptly discovered and extinguished.

Fire prevention lines are being established by ploughing a wide strip of land adjoining highways and other properties. A daily patrol has been established in addition to the patrol furnished by the state police. This will reduce the danger of fires as well as guard against pollution of the water. Additional fire fighting equipment has been purchased including a Type N Pacific fire pump with 1,000 ft. of 1½-in. hose, also 1,000 ft. 2½-in. hose mounted on 2 reels with the necessary nozzles, spanners, etc. Two additional hydrants have been placed at points where they will protect the buildings and forest in the vicinity of the pumping station.

Experiences at Buffalo, N. Y. in Cleaning Water Mains

Results Outlined in Paper Before Canadian Section Am. W. W. Assn.

By WILLIAM H. GROTZ
Assistant Engineer, Bureau of Water, Buffalo, N. Y.

OUR first experience in water-main cleaning in Buffalo was in the year 1920. During the winters of 1928 and 1919, the water pressure in certain sections of Buffalo, especially in the low service system, was found to be extremely low, particularly during the periods of heavy consumption of water. This condition was especially noticeable in those areas in which were located the large industrial plants and railroad yards.

In view of the excessive cost of laying a new feeder to this district and the fact that the mains supplying these areas were of ample size to deliver the water consumed without excessive loss in pressure, it was determined to make an investigation into the cause or causes of this condition.

Accordingly, during the summer of 1919, an inspection was made of the interior of all maines cut for repairs, new connections or alterations, to determine their condition.

The Distribution System.—At this time it might be well to state that the water distribution system of Buffalo is divided into two services, a high-pressure service having an average pressure of 50 lb. and a low-pressure service having an average pressure of 30 lb.

This inspection showed that mains which had been in the ground twenty-five years and longer were badly silted, having a deposit of mud from 1 in. to 4 in. in depth. The presence of these deposits had greatly reduced the carrying capacity of the mains, with consequent reduction in pressure.

Believing that it was possible to increase the carrying capacity of these mains by cleaning, a contract was entered into with the National Water Main Cleaning Co., in August, 1920, to clean approximately six miles of mains, mostly on low service pressure, with a view to increasing the carrying capacity and pressure.

The first main to be cleaned under this contract was a 16-in. feeder, in the low service district. It was approximately 4,200 ft. long and included a number of 45 deg. bends to dip under a tunnel and pass other obstructions. It had been laid about 35 years previous. The result of the cleaning of this main showed conclusively the necessity and wisdom of continuing the investigations.

Results of Cleaning.—Shortly after the cleaning machine had started on its journey through the main, the open end began to disgorge a thick, pasty, writhing mass of mud completely filling the open end. The emission of this mud reminded one of shaving cream being squeezed from a tube, the difference being in the color and odor. In all, fifteen dumploads of dirt were hauled away. When this main was restored to service a marked improvement was noted both in pressure and volume, in the district supplied.

Continuing under this contract, several other low service and several high service mains, comprising over 35,500 ft. of 16-in. pipe, were cleaned, with uniformly satisfactory results.

In two mains cleaned in the low service, silt to a depth of 10 in. was encountered, with the result that the capacity of the pipe was decreased two-thirds. The mains on the high service had been laid 40 years before, and while the silt in these was not excessive, the carrying capacity had been decreased at least one-half by tubercular growth and incrustation on the inner side of the pipe.

As a result of the cleaning of these mains, it was determined that low service mains laid 25 years or longer, were bady silted and that their carrying capacity could be increased at least 100 per cent by cleaning, while mains on the high service, laid 20 years or longer, were badly incrusted and their carrying capacity could be increased considerably.

The work done under the first contract having given excellent results, a further contract was entered into in 1920, providing for the cleaning of an additional 190,000 ft. of 10-in. to 20-in. mains, in the low service district. The results of cleaning these mains was extremely satisfactory, the presure at the recording gauges in various parts of the section registering an increase in pressure of from 7 lb. to 10 lb., which was from 25 to 30 per cent greater than before the work was done. Also sections which had been complaining of lack of water were now receiving an ample supply.

It was then deemed advisable and in the best interests of the city to continue the cleaning of all mains in the distribution system which had been laid 25 years or longer. The cleaning of these mains would not only materially increase the amount of water available, but decidedly reduce the friction losses in the pipe, so that a lower pressure might be maintained at the pumping stations. This was especially desirable, as practically two-thirds of the pipe in the system was of Class "A" weight and suitable for a pressure much less than that which they were carrying.

It was also highly desirable to have clean mains for clean water when the filtration plant, which was then contemplated, was completed. This plant is now in operation.

Method of Cleaning.—Cleaning a water main consists of inserting the cleaning machine or scraper into the pipe, and then forcing or pulling it through the main, cutting tubercules and other matter from the surface, and scraping out the mud, as it moves along. In cleaning the smaller mains up to and including 8 in. in size, the machine is dragged through by a cable. First a small line is carried through the pipe by a ball float. A cable is then drawn through the main by this line, and finally the scraper is pulled through by this cable, using a windlass. In mains 10 in. and larger in size, the cleaning machine is forced through by the water pressure behind it.

The procedure in cleaning a water main is simple. A section of pipe to be cleaned is valved off from the system. A cut is made in the pipe at each end for entering and removing the cleaning machine. The machine is then inserted at one end and the pipe replaced and sleeved up. At the other end a riser pipe of the same size as the main is made up with a 45 deg. bend and extended to the surface.

Table I—Amount and Cost of Water-Main Cleaning in Buffalo, N. Y.

Year	6 in., ft.	8 in.	10 in., ft.	12 in., ft.	16 in., ft.	20 in., ft.	24 in., ft.	36 in., ft.	Totals	Cost
1920	.....	.....	.....	.....	35,545	.....	.....	.....	35,545	$ 3,909.95
1920	.....	.....	70,639	78,244	54,216	17,020	.....	5,425	225,544	67,663.20
1921	25,989	.....	65,701	38,338	33,625	42,664	8,259	.....	214,576	64,372.80
1921, Extra	.....	.....	.....	.....	18,508	.....	.....	.....	18,508	5,552.40
1922	.....	.....	9,251	34,245	57,422	.....	.....	.....	100,918	27,247.86
1923	41,280	.....	17,070	32,968	44,085	6,795	4,947	2,863	150,008	40,502.16
	130,137	.....	.....	.....	.....	.....	.....	.....	130,137	35,107.02
Total	197,406	.....	162,661	183,795	243,401	66,479	13,206	8,288	875,236	$244,355.39

Water is then turned on back of the cleaning machine and the cleaning begins. The machine travels quite rapidly, making 200 ft. to 300 ft. per minute, and, coming out at the open end of the main, brings all the mud, encrusted material and other loose materials in the pipes with it. The water is allowed to run for a short time after the machine is out to flush out loose particles. The pipe is then made up and all valves opened.

The time any section of pipe need be out of service, depends upon the speed with which the pipes can be cut and sleeved up, as the time required for the machine to travel from one end to the other is very little. Usually it can be arranged so that larger mains need be out of service less than twelve hours, and smaller mains from four hours up.

In Buffalo, the work of cutting and sleeving mains, as well as the excavation, back filling and other work, was done by the contractor, the water department furnishing only two men to operate the valves and a foreman to direct and check up the work. The water department furnished pipe, specials, lead and yarn, while the contractor furnished all other materials and equipment.

The Cleaning Device.—The cleaning device usually consists of two sections flexibly connected, each having a number of tempered steel cutting and scraping blades securely fastened to a common center, the cutting blades being on the forward section. The centers are of pontoon type, providing the proper buoyancy, so that scrapers and cutters exert equal pressure on all sides of the pipe. The cutting edges of these blades form a circle somewhat larger than the diameter of the pipe to be cleaned, so that when entered into the pipe there is enough tension on the blades to cut away all incrustation. The cutting edges of the scraping blades are turned at an angle of 45 deg. to the line of pipe, so as to give a wiping contact. A leather disc mounted in an expanding steel cage is provided to propel the device through the pipes, and provision is made to allow enough water to pass the machine to carry ahead of it the silt, incrustation and other matter in the main.

The cleaning of mains laid 25 years or more was continued through 1920 to 1924, and included about one-fourth of the pipe in the distribution system. Some of the larger feeder mains still remain to be cleaned.

Cost of Cleaning Mains.—The sizes, amounts of pipe cleaned and costs, are given in Table I.

An idea of the cost of the co-operative work done by the water department in connection with pipe cleaning may be gained from the fact that the department cost on the 6-in. pipe cleaned in 1924, was between 5 and 6 ct. per ft.

It is surprising to see the amount and variety of loose objects that come out of the pipes when cleaned, especially in view of the general precautions used when laying mains to insure that the pipes are clean. These include paving stones, cast-iron tapping cuts (old style), oak sticks and wedges, iron bars, timber and what not. From a 10-in. main, an 8 in. x 8 in. x 5 ft. piece of maple was removed. A 36-in. main disgorged a 6-ft. trench ladder, a 3 ft. x 2 ft. x 1 ft. box, a small door, a tool box, tools, miscellaneous pieces of hemp, wood, etc. Large pieces of lead from joints which had missed were common, often weighing as much as 50 lb. and 100 lb. One 36-in. main was so heavily laden with silt, that when cleaned, this silt accumulated to such a depth in a low spot on an adjacent street over which a street railway was operated, as to necessitate the use of a snow plow working several hours to keep the mud off the tracks, until it could be removed and the tracks kept open for traffic.

Benefits of Cleaning.—In conclusion it might be well to consider the benefits and savings to the community by having the water mains kept in a properly clean condition. These are manifold, but a few of the important ones are:

(a) Reduction of pressure at pumping station, resulting in a coal saving commensurate with the size and age of the system.
(b) Pressure and volume increase throughout the entire system, and particularly in the remote sections, thereby decreasing fire hazards and lessening the chances of complaint from the consumers.
(c) Delay of extensive new larger main extensions.
(d) Potability and clarity of water.

Upon recent examinations of several mains which have been cleaned in Buffalo, they were found free from tuberculation, thus proving the wisdom of cleaning. It would be well for those interested in a pure potable water and a properly balanced system, to examine water mains from time to time for tuberculation and silting.

Studies on Oxidation Reduction

The Public Health Service has just issued a bulletin comprising 10 papers on oxidation reduction. These represent exhaustive studies upon certain fundamental principles of chemistry. They will be especially useful to chemists and to students of chemistry. They papers have already appeared separately in one form or another, but the demand for reprints has warranted the Service in collecting them under one cover.

The following list of subject headings of the different papers will give a conception of the scope of the studies collected in this bulletin:

I. Introduction. By W. Mansfield Clark.
II. An analysis of the theoretical relations between reduction potentials and pH. By W. Mansfield Clark and Barnett Cohen.
III. Electrode potentials of mixtures of 1-naphthol-2-sulphonic acid indophenol and the reduction product. By W. Mansfield Clark and Barnett Cohen.
IV. Electrode potentials of indigo sulphonates, each in equilibrium with its reduction product. By M. X. Sullivan, Barnett Cohen, and W. Mansfield Clark.
V. Electrode potentials of simple indophenols, each in equilibrium with its reduction product. By Barnett Cohen, H. D. Gibbs, and W. Mansfield Clark.
VI. A preliminary study of indophenols: (A) Dibromo substitution products of phenol indophenol; (B) substituted indophenols of the ortho type; (C) miscellaneous. By Barnett Cohen, H. D. Gibbs, and W. Mansfield Clark.
VII. A study of dichloro substitution products of phenol indophenol. B. H. D. Gibbs, Barnett Cohen, and R. K. Cannan.
VIII. Methylene blue. By W. Mansfield Clark, Barnett Cohen and H. D. Gibbs.
IX. A potentiometric and spectrophotometric study of meriquinones of the p-phenylene diamine and benzidine series. By W. Mansfield Clark, Barnett Cohen, and H. D. Gibbs.
X. Reduction potentials in cell suspensions. By R. K. Cannan, Barnett Cohen, and W. Mansfield Clark.

Copies of this bulletin may be obtained by addressing the Suregon General, United States Public Health Service, Washington, D. C.

Short Courses for New Jersey Sewage Plant Operators

Short courses for sewage plant operators of New Jersey were carried on again this year under the direction of the College of Engineering of the State University, the New Jersey Sewage Works Association, and the State Department of Health. The courses extended over a period of two weeks (Jan. 16-27, 1928), consisting of laboratory practic, lectures and recitations, and field trips. For the persons who attended the initial course last winter or had equivalent training, advanced laboratory work was arranged under the direction of Dr. Willem Rudolfs. The laboratory work of the first semester class was in charge of Dr. P. A. van der Meulen. Professor H. N. Lendall had the general supervision of both courses. In addition to these members of the faculty of the State University, representatives of the State Department of Health and municipal sanitary engineers lectured.

Black Base in Southern States

Extract from Paper Presented at 6th Annual Asphalt Paving Conference

By WARREN H. BOOKER
Consulting Engineer, Charlotte, N. C.

BLACK base in the South is neither a novelty nor an innovation. Some of the earliest black base laid in the South was a project of approximately 30,400 sq. yd. on Liberty St., Savannah, Ga., in 1889. This pavement was resurfaced in 1908 and from a recent report, the pavement is in good condition and rendering excellent service today. Although asphalt streets were laid in Washington, D. C., as early as 1876 the use of bituminous concrete as a base course in the Southeast probable dates back to the laying of the Savannah project thirty-eight years ago. The black base pavements in Washington are the oldest of the type of which I am aware. Many thousands of yards are now in existence and range in age from 35 to 45 years.

Today black base, in some form, is being laid in nearly every Southern state, and within recent years the amount laid each year has been increasing by leaps and bounds.

As previously stated, black base is closely allied to other forms of flexible construction.

The true black base pavement is one composed of a coarse aggregate asphaltic concrete only, as a base, usually with some approved type of asphalt wearing surface, laid directly on a stable earth sub-grade. The dimensions of this type for the heaviest traffic should be 4½ in. of black base and 1½ in. of wearing surface. Although for medium traffic the thickness of this pavement can safely be reduced to 3½ in. of black base with a 1½ in. wearing surface. In state highway construction an inverted harder curb of black base should be used. In city work the curb and gutter suffice.

Triaxial Diagram for Black Base.—For several years the writer has used very successfully the little triaxial diagram issued by the Asphalt Association for selecting and proportioning sheet asphalt sands. This little diagram has proven a convenience, a great time-saver and a ready means for not only setting the original mix but more especially, for considering extraction tests and comparing laboratory results with specification requirements and directing the necessary modifications of the proportions to meet the ever-changing size gradings found in the stock piles.

On a recent black base project, the writer took occasion to adopt this same triaxial diagram to similar uses in connection with black base work. Since the usual specifications for black base call for a 3-size grading by percentages of weight, this triaxial diagram, it will be seen, can readily be adopted for proportioning mineral aggregates for black base as well as sands for a sheet asphalt mix. In fact, this triaxial diagram can be used with any mineral aggregate regardless of size, just so there are 3-size gradings governing.

In the usual specifications for complete black base mixes the three sizes of mineral aggregate by percentage are from 15 per cent to 45 per cent of coarse material ranging from 1½ in. to ¾ in. in size; 15 per cent to 45 per cent of intermediate material ranging from ¾ in. to ¼ in. in size and 25 per cent to 40 per cent of fine material passing a ¼-in. screen together with from 4 per cent to 7 per cent of asphalt cement. These percentage limits for mineral aggregate alone allowing 5 per cent for asphalt cement have been plotted on the triaxial diagram to adopt it for use for black base.

As in the case of sheet asphalt, the limits of the standard specifications are rather wide, which tend to make it comparatively easy to get a sheet asphalt or black base mixture to come within the specification limits. By means of the triaxial diagram any particular sand, gravel, stone or combination of aggregates is represented by just one point readily ploted on this chart and from this point one is able to see at a glance not only just which way and how much the mixture differs from the ideal but just what material and how much is needed to make the resulting mix more nearly approach the ideal mix desired.

The Sub-Grade.—In laying black base, perhaps the greatest single consideration should be for sub-grade. In general, the sub-grade in the South is usually either a sandy, gravelly material from which the water drains readily, except where the adjacent land is wet, swampy and undrained for at least a portion of the time; or else the sub-grade is a close, dense, clayey material from which the water drains with difficulty.

Black base is admirably adopted to the latter case and is coming to be used more and more where the former type of material is encountered.

Improving Sub-Grade.—In the case of sandy, gravelly, or but partially drained soils which cannot be compacted by rolling or ordinary methods the remedy is to be found very largely in adequate drainage in one or more of the various forms ordinarily used, and especially, by filling in with suitable material and raising the elevation of the sub-grade well above any possible water level.

Where adequate drainage is impractical, or where all or a large part of the sub-grade is spongy and cannot be readily compacted by means of a 10 to 12-ton, 3-wheel roller, a black base is not to be recommended unless the sub-grade can be in some way improved or rendered capable of adequately supporting the pavement.

As a means of improving wet sub-grades, it is surprising to note the effect of placing a roof of water-proof bituminous pavement upon a questionable sub-grade. In many instances, sub-grades that are ordinarily too wet become entirely satisfactory for sub-grade purposes after they are covered with a roof of water-proof black base and pavement. It is well known that more trouble results from wet and softened sub-grades resulting from cracks and leaks in the pavement than from lateral percolation into the sub-grade under the pavement.

In cases of local, soft, spongy places where stumps have decayed or where holes or ditches have been filled with organic or other objectionable matter, the remedy is simply to replace this matter or a sufficient amount of it with good sub-grade material, thoroughly compacted.

In other places the sub-grade can readily be improved by means of a broken stone sub-base, clay-filled gravel, or similar material compacted to a depth of from 2 in. to 5 in., as the local condition may require. Such a sub-grade greatly improves the situation by increasing the bearing area and thereby reducing the unit loading on the sub-grade. In such cases the thickness of the black base can usually be safely reduced to from 2 in. to 3 in.

Green Fills.—Green fills are sometimes almost unavoidable. Frequently they must be made to support traffic on some form of pavement. In such cases where uneven settlements occur the flexible black base gradually conforms to the settled sub-grade without breaking, cracking or raveling, thereby deriving the maximum supporting power from the sub-grade. Where it is later desired to level up the wearing surface, this may readily be done at nominal cost by means of leveling patches without, in any way, disturbing the base. In addition to the leveling effect of these patches, by increasing the thickness of the pavement they materially increase the area of the bearing surface for the distribution of load or impact and correspondingly decrease the unit foundation loading over places of demonstrated sub-grade weakness.

Sewer Trenches.—Sewer trenches under city pavements, in the writer's experience, seem to give little or no trouble with the use of black base if the sub-grade and upper part of the sewer back-fill are thoroughly rolled and uniformly compacted. In rolling sewer or other trenches, where practical, an effort should be made to have one rear wheel follow down the old trench line, experience indicates that paticularly in narrow sewer trenches the arching effect, if the upper foot or more of back-fill is thoroughly compacted, furnishes surprisingly good sub-grade support. This statement is not

to be taken as a license to omit the tamping of back-fill in sewer trenches but rather to indicate that surprising strength of sub-grade is developed in spite of adverse conditions.

With further reference to the matter of sewers in city streets, it is the writer's opinion, that by reason of more or less infiltration of ground water into these sewers, the ground water level under pavements over sewer lines is in many places considerably lowered. This is particularly true in low places in streets where sewers are nearly always present and where the need for this unintentional element of drainage is usually greatest. This lowering of the ground water level greatly improves sub-grade conditions. With the arching effect at least in the upper part of the sewer trench, with the added improvement of drainage by infiltration into the sewer below and the still further aid of a water-proof black base roof above, little trouble need be expected from sewer trenches.

Water Trenches.—In the city street work, however, the matter of leaky water mains and service connections should be given particular attention. This past summer the writer was engineer on some 5 or 6 miles of black base work in a small town where the sub-grade consisted of dense, tight, almost impervious shale. The water mains had been laid entirely too shallow. A casual examination of the surface of the uncompacted sub-grade showed that at least one-third of the joints in these water mains were leaking. Some joints were leaking to an extent which would endanger any kind of a base on a sub-grade of shale which we know but a short time ago, geologically speaking, was simply mud and ooze. When rolling began, wet, quaking mud holes developed at intervals of 12 ft. or multiples of 12 ft. over these leaky joints.

In this case, the policy was adopted of first caulking the worst leaks in order to dry up the mud holes sufficiently to permit thorough rolling of the sub-grade and the back-fill in these water trenches. It was thought that this rolling and any consequent movement of the back-fill and water pipe, would develop all the leaks in the water mains that would ever give trouble. After this rolling, each bell hole was opened and the joint inspected. It was found that practically every joint was leaking to some extent. The lead joints were then recaulked until the leaks were stopped and the back-fill rammed into place. By this means, only two joints on the entire job gave any subsequent trouble.

Examples of Bad Sub-grade.—After all, the surprising thing about sub-grades for black base construction are the examples of the successful use of black base on sub-grades ordinarily considered as being not well adapted for this type of pavement. Take, for example, the Great Coastal Highway in South Carolina and Georgia. Here much of the sub-grade is fine sand with a considerable amount of finely divided decomposed vegetable matter. Of the 70 miles of black base construction on this highway thus far, over the better portion of the sub-grade a 4½-in. course of black base is laid with 1½-in. sheet asphalt surface, while in the worst sections a 3-in. course of black base with a 1½-in. sheet asphalt surface is laid on 5 in. of clay-filled gravel. In other sections, an original graveled roadway is salvaged to excellent advantage by applying a 3-in. black base to the old graveled way and using a 1½-in. sheet asphalt top.

C. N. Conner, Chief Engineer American Road Builders' Association

The American Road Builders' Association announces that C. N. Conner, of the Highway Research Board, has been retained as chief engineer of the association.

C. N. Conner, Chief Engineer, American Road Builders' Association

Mr. Conner has had wide experience as a road builder and exceptional experience as a committee worker. He has recently been chairman of the committee on Low Cost Improved Roads, operating under the Highway Research Board. Mr. Conner was graduated from Tufts College in 1908. For three years he worked as engineer in railroad construction, and later was assistant engineer with the Bureau of Public Roads in the Philippine Islands. His next position was assistant engineer with the War Department and then with the Navy Department. He then became assistant engineer with the Delaware State Highway Department, and after that was State Construction Engineer for the North Carolina Highway Commission, where he was also head of the testing and research laboratory for a brief period. During 1925 and 1926 Mr. Conner was chief engineer of the Mexican Federal Highway Commission. He is a member of several technical organizations and author of many articles which have appeared in technical publications.

Mr. Conner's work for the present will consist of co-ordinating the activities of the committees of the several divisions and arranging for the committee reports which will constitute the program of the next convention. The County Highway Officials' Divison, the Highway Contractors' Division and the City Officials' Division will operate through committees and their reports form the basis of the program for the next convention.

The American Road Builders' Association will organize in addition to its present committees several committees that will deal with problems of national interest. The program for the 1929 convention of the association will consist essentially of reports of the chairmen of the various standards committees. These reports will represent the work of the committees during the entire year, and every effort will be made to present them in a manner that is clear, interesting and concise.

The retaining of Mr. Conner as chief enigneer of the association marks another step in the development and usefulness of the association.

How to Prevent Cracks in Asphalt Pavements

Useful suggestions on raking and tamping at joints of asphalt pavements are given in a letter to J. E. Pennybacker, secretary and general manager, The Asphalt Association, by Jesse Henderson, an employee of the municipal asphalt plant of Cleveland, O. Through the courtesy of Mr. Pennybacker we are able to reprint his letter as follows:

"I believe I know what are the causes and where to lay the blame, in cracks that appear in asphalt pavements especially the joints.

"As I have been an asphalt raker for over 18 years, quite naturally I've noticed this before. But for the past three years, by working for the Municipal asphalt plant at Cleveland, has given me the chance to experiment and test out my theory.

"You know practically all cracks, even if they don't extend across the joint, will start from the joint. Some of the causes are varied, such as merely painting and overlapping of joints, other than sheet asphalt. "But the main causes are in the raking and tamping.

"A raker should pack his joint with his rake and comb it thoroughly, and have his tamper tamp it properly and soundly, 'to compact it,' and seal his joint with the tamper, then the smoother should finish, 'although not needed,' burning or grafting hot and cold joints together.

"As it is a raker usually combs his stuff on top, leaving that next to the base, just like it was shoveled making it look alright on top, but the trouble is underneath and can't be seen until cracks appear. They will work down or across the sheet underneath to a weak place on top, then the weather does the rest. And as for cracks straight across the joint, a tamper usually just tamps a few light licks, don't seal his joint and a smoother comes along and fixes it up. Now all a smoother does when he does this is just merely bringing the asphalt cement out to shine, if he comes to a hole or a nest of honey combs he just smooths a little over. It makes it look alright for the present, but in a short while your joint is bound to open up, and then it will extend in all directions.

"Also quite a few cracks can be laid to not properly rolling."

Badly Needed Drives Built on Made Land in New Park Project

Through Traffic Boulevard and Park As Part of City Plan of Chicago Under Way

THE Chicago South Parks Commissioners are at present involved in an enormous project that will afford two new high speed traffic arteries that will connect the south side with the north side, and that will connect with a similar plan now being advanced in their own territory by the Lincoln Park Commissioners on the north side. The work being done on the south side is a part of the comprehensive City Plan that has been evolved by D. H. Burnham, the famous city planner and architect, with the cooperation of other planners, and it provides badly needed traffic arteries along the shore of Lake Michigan that will permit through traffic to be expedited by means of a routing that will not involve passage through the congested downtown business section. Not only does the plan include splendid through streets of scenic as well as practical value, but it includes as well the development of miles of park, bathing beaches, and other recreational facilities along a shore line that previously was partly devoted to railroad tracks.

This project was made possible by means of a very extensive program of making land by a combination of methods, thus moving the lake shore outward and providing grounds that would not otherwise have been available without expensive condemnation of valuable property.

Extent of Work.—The project in the jurisdiction of the South Park Commission, that involving the work south of Randolph Street and extending to Jackson Park and including Grant Park, involves a total fill of 1,100 acres over a length of about 6½ miles. It provides a strip of made land along the shore 300 to 500 ft. wide, then a series of lagoons 400 to 500 ft. wide, and on the outer side of these lagoons a series of islands running from 400 to 2,000 ft. wide. The total fill will aggregate about 50,000,000 cu. yds. by the time the work is completed. Channels will be left between the islands, four channels in all, and these will be spaced about one each mile. These channels are intended to provide access to the lagoons as harbors of refuge and yacht harbors and to provide free circulation of water between these lagoons and Lake Michigan. A wide drive will be built along the inner strip and another through the chain of islands, the latter crossing from island to island by means of bridges spanning the channels, and the drives interconnected at half-mile intervals by bridges spanning the lagoons. At the same points, viaducts will be built spanning the tracks of the Illinois Central Railroad that runs along the old shore to connect with existing city streets. The inner and outer drives will converge at the Field Museum in Grant Park and on the southern end of the project. Grade

(Chicago Aerial Surveys)

Aerial View of Fill South of Grant Park Showing New Island, Bulkheading, Completed Fill, and Progress on Roadway

Scow Fill Being Made Behind Bulkhead, and Dipper and Clamshell Dredges Keeping Channel Open

separations will be made at all intersections in order that no line of traffic will cross another on the same level and provisions will be made for pedestrians as well.

The inner drive, known as Lief Ericsson Drive, located on the shore strip that will be known as Burnham Park, is to be 70 ft. wide. This drive is now in use from Grant Park to 23rd Street, and is under construction from 23rd Street south, and will be advanced as the fill is completed. Since the pavement is to be placed on new fill, these drives are being constructed of asphaltic macadam with rock asphalt surface.

Structures.—For the most part the bridges and viaducts will be built of structural steel, of the girder type, encased in concrete, resting on concrete piers and abutments, but some of the shorter spans may be built of reinforced concrete. A total of 28 bridges and two subways have been planned.

Underground Work.—The necessary underground services are being installed as the work progresses, such as storm sewers, water mains, sanitary sewers, electric conduits, etc. The sanitary sewers will be carried across the railroad and drain into the city system interceptors, while the storm sewers will outlet into the lake. The fill will be covered with black dirt to a thickness of at least 10 in., while at the point where trees and shrubbery will be planted the depth of the black dirt will be 18 in. or more. This black dirt is to be shipped to Chicago by rail and hauled to the park by motor truck. Separate contracts will be let for planting and for sidewalks, etc.

Letting the Work.—This work to cost about $100,000,000 in all, was started in the fall of 1920, and is progressing as rapidly each year as funds permit. The work is being let in sections of varying length and yardage, in each case to the contractors who were able to make the best bids or combination of bids for that section. In this way fill methods vary with the section, with only one contractor involved in some cases and with several involved in others, each with his own method of filling. For the past two or three years the filling has progressed at the rate of 2 or 3 million cu. yds. a year, and to date the project is about 25 per cent completed after an expenditure of about $21,000,000.

Bulkheading.—The first step in the progress of the work is the construction of the bulkheads that will act as breakwaters or seawalls and that will retain the fill. A triangulation net was first laid out from the shore, range piles driven, and soundings made. These range piles not only gave a guide for further bulkheading operations, but gave a measure of the pile lengths necessary to complete the job according to the specifications. During this stage of the operations it was found that 50 ft. piles were required at the north end, while the shortest that were needed were 35 ft. Specifications called for piles of mixed hardwoods, including cypress, with 12-in. butt and 6-in. point, driven to grade in about 20 ft. of ground, thus requiring good penetration into clay. The piles were driven to 5 ft. above the water line, the waterline being approximately datum.

The bulkheads were constructed of double rows of piles close driven, except where sheet piling was used, with timber walers on the inner row and steel channel walers on the outer or water side of the bulkhead, with bolted tie rods tying the the two rows together at the walers, and the space between the piles filled with stone. In some cases Wakefield sheet piling was used, sometimes on the water side of the bulkhead, sometimes in between the piling, but for the most part on the fill side, with the adjacent piling spaced on 2-ft. centers, and with the tie rods running through the sheet piling as well as through piles and walers. The steel channel walers, of 18 in., 16 lb. per ft. steel channel in 30-ft. lengths, were used on the water side since they have been found to be more resistant to ice action and damage from boats than timber walers. These were turned flat side to the piling and the ends spliced with splice plates as are railroad rails. These channel walers were found to conform to curves as well as to tangents with but little manipulation. Timber walers on the inside were of two 6 by 12 timbers with the 12-in. dimensions vertical, and so laid in a staggered position that they made a build-up continuous 12 by 12 waler. On the rock sides of the piling a single row of 6 by 12-in. walers was used. Each pile was bolted to the waler, and tie rods running through the entire assembly were spaced on 4-ft. centers. Each bolt or tie rod was equipped with nut and washer on each end.

The rock fill used was quarry run waste limestone in sizes up to 1 ton and graded so as to make a compact fill, while a top dressing of cover stone was used to finish off the work, made up of specially selected stone of a minimum weight of 1 ton. Even this large stone has frequently been dislodged and moved a hundred feet or so by wave action, so the size of this rock, particularly of the cover stone, is of real importance.

Where the ground is soft or where for any other reason additional strength is needed, riprap is deposited against the bulkheading. This riprap is composed of limestone in the same sizes as the core rock, with coverstone of the larger blocks already described.

First Fill.—The work of building up the fill proceeds essentially in four lifts. First somes the general fill that brings the fill to just above the water level. On top of this comes the embankment fill, which is followed by any additional fill required for the roadways. The final fill consists of the laye of black dirt required for the planting scheme. While this latter work is done entirely separately, somecontracts have been let on the basis of the same equipment being used to make the first three fills in one operation, while others have been let on the basis of one contractor doing the first, another contractor doing the second by other methods, while the roadway may or may not be built up as a third op-

eration. The first fill can be made in three different ways, and all three are being used, while the second and third fills can be and are being done by two different methods.

Dredge Work.—As soon as the bulkheads had been constructed, the work of bringing the land up to datum was begun. Here a combination of methods was used. Scows of spoil from buildings and other excavations were hauled in and dumped where required until draft needed for this mode of transportation was no longer available. A large dipper dredge and a clamshell dredge were used to keep channels open and to rehandle the material thus dumped, by cut and cast, in order to build the materiel up to about datum.

Hydraulic Dredges.—On the north end, where the bottom was found to be of clay, ladder dredges (suction dredges) were used in conjunction with a pipe line to make the same sort of fill. To the south, where the bottom was found to be a shallow cover over rock, and with two reefs actually breaking the surface, the use of ladder dredges was not feasible, and while the dumping of spoil from barges could still be counted upon for a part of the fill, a third method had to be resorted to. This method, useful over the entire length of the job where contracts had been awarded on that basis, consisted of picking up a load of sand in a sand boat about 14 miles from the job, transporting this sand in the sandboat to the job, and then discharging the load from the hold to the fill through a pipe line. A great deal of the fill has been made in this manner.

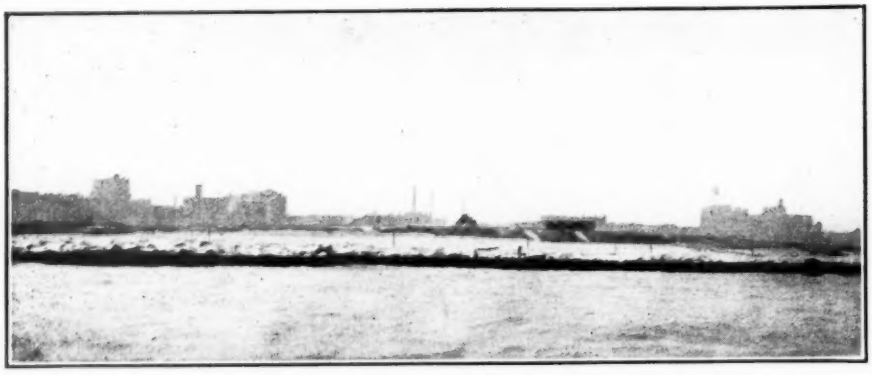
Embankment Fill.—The next lift, that of general grading above the water level, is being done by the sandboats, and this method is being supplemented by dumping from motor trucks, which obtain their material from building and other excavations throughout the city. While the usual practice with sandboats does not include the building up of roadway embankments, high banks, etc., one of the sandboat contractors has patents covering such fills, and his methods are being used on the portions of the work being done by his concern. This contractor, the Construction Materials Company, by means of high pipe lines, clay or sand and canvas dykes, and drains, is able to build up to any level encountered on this job, and to build up a fill that conforms to any ordinary area, roughing out any landscape or roadway fills to line and grade at a reasonable cost. Two of his sandboats, both of large capacity, are being used on this work. Similar boats are being used by other contractors on other sections of the work.

Roadway Fill.—Final preparations for the roadways is made by building up a clay sub-grade by hauling in clay on motor trucks from various excavations throughout the city. This fill is of course well compacted by the trucks as they drive over it, but a rolling is also specified, using a 10-ton roller. Besides this type of subgrade, ordinarily fill is secured in the same way at the rate of about 10 acres a year. some subgrade is built up by the sandboats.

Underground Work.—Prior to paving, all underground work is done under separate contract, using ordinary methods. Since this involves only trenching with an ordinary trenching machine, laying the pipe and conduits in the established manner, and backfilling with backfiller, no further description of this work needs be made at this time.

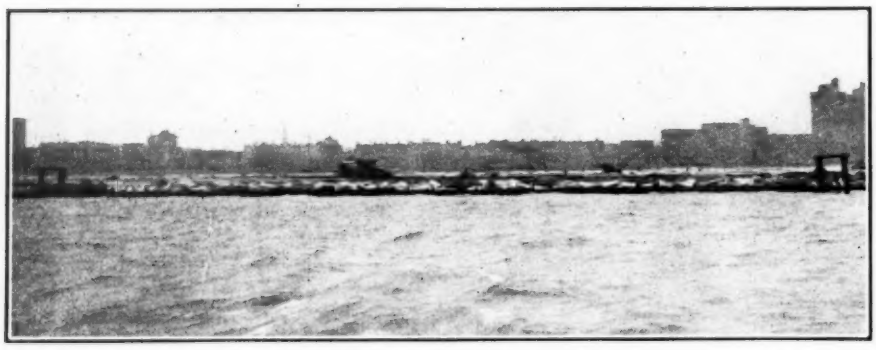
(Chicago Aerial Surveys)

View of Work North of Jackson Park Showing Progress on Inner Drive



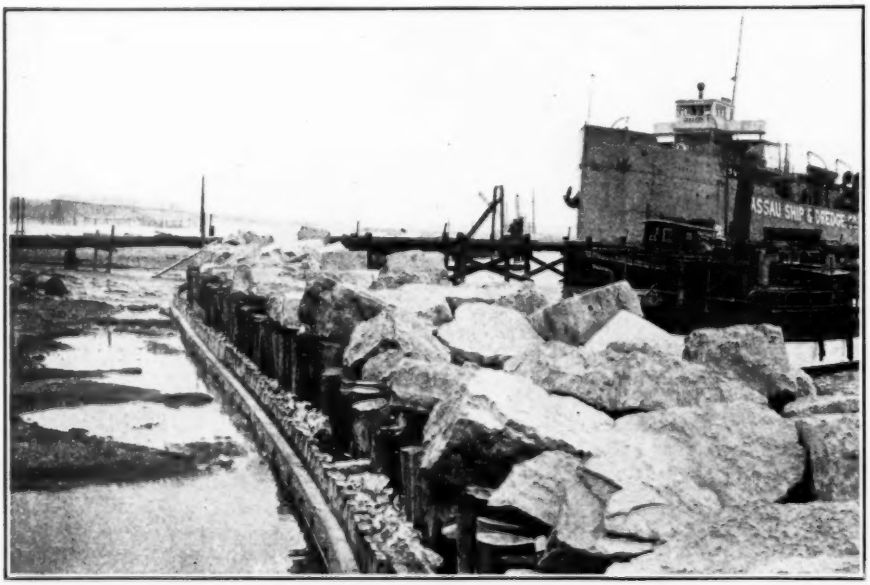
Trucks Making Fill for Inner Drive, as Seen From the Lake

Paving.—As soon as the roadway fills are completed and fully compacted, usually allowed to season for a year, the paving operations are begun. Here the subgrade must be finished and a macadam or concrete base be laid for the sheet asphalt pavement. No paving was under way at the time this article was written, so the methods used on this part of the work cannot very well be described.



Underground Work in Progress With Trencher at Work

Summary.—This work is being done for the South Park Commissioners, represented by Linn White, chief engineer, and John P. Ball, resident engineer, by a number of contractors. Bulkheading was done by the Great Lakes Dredge & Dock Company, and this same firm are utilizing scow fill and operate hydraulic dredges, dipper dredges, and floating cranes. Their work is done under the active direction of Capt. Wm. Murphy, who is assisted by Carl Nelson, superintendent, and Robert Ketchum, assistant superintendent. Sandboat equipment is operated by three firms, each using two boats. These are the Central Dredging Company, operating the "Bay View" and the "Chicago"; Construction Materials Company, operating the "Sandcraft" and the "Sandmaster"; and the Illinois Ship and Dredge Company, operating the "Brazil" and the "Nassau." The Great Lakes Dredge & Dock Co., operates the "New Jersey," a 30-in., 4,000 h.p. Diesel electric hydraulic dredge; the "New York" and the "Illinois," two steam driven hydraulic dredges; the "No. 21," an 8-yd. dipper dredge; the "No. 48," a 7-yd. dipper dredge; and other floating equipment. Contracts are let in sections on the basis of the best bids for all work or parts of work in that section, accounting for the variety of methods used.



Inner Face of Bulkhead With Sheet Piling. The Large Vessel Is a Sand Boat Making Fill

Stock Salt Used to Melt Ice Surface

On the Pacific Highway in the vicinity of Weed, Calif., difficulties are encountered by the freezing of snow and the formation of ice on the concrete pavement. This is particularly true on curves, especially where occurring on maximum grades.

This condition, in part, is overcome, in so far as slipperiness is concerned, and the road rendered reasonably safe for travel, by a thorough sanding of the surface. Under this method there is a tendency to build up the ice sheet and prolong the hazard to the public, as well as materially increasing maintenance costs, due to purchase of materials and their daily application. In an endeavor to overcome delay, to reduce costs, and render better service to the public, various substances and methods have been tried in the past on the ice sheets. The results indicate that the application of approximately 50 lb. of stock salt to 400 lin. ft. of 18-ft. pavement, evenly broadcast by hand, will so decompose an ice sheet two to three inches in thickness, that in the course of four or five hours it can be removed by means of a towing grader powered by a 30-h. p. tractor.

The use of salt is not advanced as a cure-all for ice conditions. Its use, however, is justified at times, especially when melting is delayed, or where grades or curvature make it imperative to remedy the condition at once, and where sanding is either not economical or ineffective. For the treatment of the block ice or thin glaze, sanding by means of hand shoveling or spreader trucks is the most effective.—California Highways and Public Works.

Iowa Awards $796,562 of Highway Contracts.—On March 27 the State Highway Commission of Iowa awarded contracts for 21 miles of hard paving, nearly 30 miles of grading, and construction of 91 bridges and culverts.

An Accounting System Which is Simple

Paper Read at Convention of Kansas Water Works Association

By G. W. PAULETTE
Water Works Superintendent, Emporia, Kans.

Perhaps the most abused, least understood, and hence, the most neglected part of the average municipally owned water department, is its accounting system. I say this because I question whether there are half a dozen water department accounting systems throughout Kansas that could stand the close scrutiny of an expert accountant without arousing considerable constructive criticism. The cause of this generally existing condition of our department accounting systems is due to several factors, among which are: first, the fact that we, as technical engineers, are prone to over-emphasize the engineering phase of our work to the detriment of the business administration of the department; second, that the accounting records are generally in the care of city clerks who, as a rule, are of the older generation, who do not take kindly to keeping ahead of modern accounting practice; and third, and lastly, that there is always a decided inertia on the part of the governing board of the city towards making any radical improvements even though they admit the unquestionable desirability of such.

Must Know Accounting.—The trend of present day demand, however, is such, I believe, that the department executive of the near future must not be only an engineer of unquestioned ability, but also an accountant of reasonable caliber. In other words, the public is demanding that the Water Superintendent of the future be just as thorough in his knowledge of accounting as in his own engineering vocation; that he be not only capable of spending money economically, but that he be also able to show them how to equitably provide the necessary funds for such expenditure. This demand is due to the ever-increasing competition from the private owned public utility. I mean by this, that competition is creating the demand for good business administration of our water departments, otherwise the public owned water department will gradually be absorbed by the private utility. And I say to you, that a business of such magnitude as even the small town water department cannot be operated to the highest degree of intelligence and efficiency without modern accounting, and the resulting information as to the status of business affairs that it affords.

With this in mind, I will briefly relate some of the more important details of the Eureka accounting system, which was installed in January, 1926.

A Practical System.—Some of these details are a matter of common procedure elsewhere, while others are in the nature of an innovation in water works accounting, as generally practiced. The system at Eureka was installed to obtain the maximum utility with the minimum of effort; care being taken, however, to conform strictly to thorough auditing whenever desired.

Prior to the installation of the new records, a complete rate analysis was made for the department. To obtain the necessary information for this analysis it was first necessary to make a complete valuation of the physical assets of the department, which were divided into the following groups:

Storage Capacity:
- Dams and Reservoirs
- Vit. Clay Flow Lines
- Cast Iron Flow Lines

Filter Plant:
- Buildings and Reservoirs
- Motors, Pumps and Equipment
- Land
- Intake

Distribution System:
- Cast Iron Mains
- Galvanized Iron Mains
- Valves and Hydrants
- Meters and Accessories
- Sand Pipes

General:
- Office Equipment
- Shop Equipment

Operating Expense.—This valuation made, the next step was to examine the preceding two years records of disbursements to determine the average operating expense of the department. This was allocated under the following groups:

Dams and Reservoirs:
- Labor
- Tools and Supplies

Plant:
- Power
- Chemicals
- Labor

Miscellaneous Tools and Supplies:
- Laboratory Tests, etc.
- Miscellaneous Labor

Distribution and Collection:
- Office Salaries
- Miscellaneous Labor
- Shop Labor
- Meter Labor
- Freight and Drayage
- Office Expense
- Shop Expense
- Miscellaneous Expense

General:
- Superintendence
- Miscellaneous

Customers' Subsidiary Ledger. — A complete check of the customers' subsidiary ledger was then made, covering a period of two years; consumers being divided into three classes, and the number of consumers and average monthly consumption of each determined. The three classes of consumers are as follows:

Domestic, or those using less than 25,000 G. P. M.

Commercial, or those using from 25,000 to 100,000 G. P. M.

Industrial, or those using from 100,000 G. P. M. on up.

This classification is in line with a modification of the rate classification recommended by the American Water Works Association.

Other information obtained was concerning the bonded indebtedness of the department; which included amount of outstanding bonds, their date of issue, date of maturity, nominal rate of interest, amount of interest accrued, and date when interest payments became due.

This concluded the preliminary investigation, the results of which permitted the setting up of a rate schedule, adequate to meet all operating expense, and, in addition to provide for amortization of bonded indebtedness.

Monthly Revenue.—The total average monthly revenue needed was then estimated from facts obtained in the preliminary investigation under the following groups:

Depreciation
Repairs
Bond Amortization
Operation Expense
Bond Interest

The operation total consisted of an average of past operation expense plus such additional expense as seemed necessary to include for the purpose of satisfactory operation. For instance, an item of laboratory maintenance was included so as to permit of both chemical and bacteriological tests.

The bond interest included the interest on all outstanding bonds so that the semi-annual bond interest payments would be available when due.

The bond amortization requirement amounted to a sum sufficient to retire all outstanding bonds at their respective dates of maturity. This item in itself made quite a load for the department because of the fact that no provision had been made theretofore to retire any part of recent bond issues.

Depreciation.—Estimated depreciation at reasonable rates was set up on all depreciable fixed assets, as was also the estimated average monthly repairs. For the sake of simplicity the depreciation was set up by the straight line method, in preference to the working hour, production, reducing charge, or uniform rate on diminishing value, method. For a similar reason, repairs were set up on the same basis. Depreciation, however, was not made to include obsolescence of unusual nature, as such an item is properly chargeable directly to surplus and hence would not affect operating profit and loss for the period in which such obsolescence

occurs. The effect of these two reserves is to stabilize operating profit and loss from year to year, eliminating, or at least minimizing, unusual financial burdens due to unusual repair or replacement, by distributing the cost of such over the life of all assets.

Revenue Sources.—The total necessary revenue to balance the above estimated requirements was provided on the basis of probable slight yearly increases in number of consumers, and total consumption, from the following sources:

Hydrant Rentals	Incidental Revenue
Service Charges	such as Interest,
Consumption	Penalties, etc.

The hydrant rental charge was based on a fair estimate of the additional fixed charges on mains made necessary by increased size required for fire-flow, also the total fixed charges on fire hydrants and maintenance of the same, and the estimated average value of free water provided for extinguishing fires. This cost was charged directly to the tax levy in the form of a hydrant rental amounting to $5.00 per hydrant per month, and was the only item of revenue received by the department from the general tax levy. I might add here that the water used by the fire department is the only free water permitted throughout the system. Inasmuch as fire protection is valuable in direct ratio to the value of property protected, a general tax to meet the cost of this item is the only equitable way of distributing the cost.

Service Charges. — Service charges were based on the total fixed charges on meters and accessories, and such items of expense as distribution of bills and collection of same; all of which expense should be borne equally by all consumers, or in ratio to their rated meter capacities. The resulting service charge amounted to $0.55 for ⅝-in. meters with a sliding scale upward for larger meters.

The balance of the needed revenue after incidental income was deducted, was obtained from direct consumption charges, which were set up as follows:

The Domestic rate for consumers using from 0—25,000 G. P. M.....40c per m. gal.
The Commercial rate for consumers using from 25,000—100,000 G. P. M.....26c per m. gal.
The Industrial rate for consumers using 100,000 G. P. M. and Up..17c per m. gal.

The net result of this rate, while it meant an increase in consumption charges and the substitution of a service charge for a minimum, has been satisfactory to the public and the department during the past year. It also shows promise of proving satisfactory for a period of several years to come, until the department at once again becomes sound financially—at which time a re-analysis should be made — and changes in rates made, if necessary.

New System Installed.—Conforming to the desire of the City Commission, then in office, to reorganize the accounting records as well as the rate schedule, an entirely up-to-date double entry system of bookkeeping was installed. I want to emphasize here the necessity of double-entry work, if reliable and complete financial information is desired. Pure single-entry bookkeeping is a system in which accounts are kept with persons only; the two chief disadvantages of which are the inability to prove the work, and the inability to prepare a reliable statement showing the sources of profit and the nature and amount of the expenses. Trial balances in single-entry systems are, of course, impossible; and auditing reveals the lack of sufficient supporting information to permit of complete examination of the financial history over the period of audit. In double-entry systems, however, accounts are kept not only with persons, but also with other real accounts such as capital assets, merchandise, etc., and also with nominal and mixed accounts such as reserve for depreciation, accrued bond interest, profit and loss, and surplus. Double-entry work is at all times subject to trial balance, complete profit and loss statements, and balance sheets, and last, but not least, thorough and satisfactory auditing.

The System.—The system installed at Eureka consisted of the following:

A General Journal
A Cash Receipt Journal
A Cash Disbursement Journal

Which are books of Original Entry.

A Control Ledger
A Subsidiary Customers Ledger and a Cost Ledger

Which are books of Final Entry. The three Journals and the control ledger were combined under one regular loose-leaf ledger of 8½ by 11½-in. sheet size. The two subsidiary ledgers were installed in a Kardex-Rand steel filing cabinet, capable of holding 1,200 accounts of 6 in. by 8 in. size.

Subsidiary customers ledger accounts were kept with each customer purchasing water or other service from the department.

Subsidiary cost accounts were kept on all the groups of operation expense included in the classification mentioned under discussion of the rate analysis.

Subsidiary accounts were also kept for capital assets, depreciation and reserve for repairs, corresponding to each group of assets named heretofore under fixed assets.

Control Ledger.—The schedule of accounts in the control ledger is as follows:

Assets:	
Cash in City National Bank	1
Petty Cash	6
Accounts Received (Control)	9
Accounts Bank Interest	12
Stores Invent. (Control)	15
Fixed Capital Assets (Control)	20
Reserve for Depreciation (Control)	20 R
Reserve for Repairs (Control)	21 R
Liabilities:	
Aud. Vouchers	40
Accounts Payable (Meters)	41
Account Balances	50
Acct. Bond Int.	65
Bonds Outstanding	70
Surplus	74
Inc. and Exp.	
Sales—Revenue (Cont.)	80
Refunds (Cont.)	90
Direct Operation	110
Repairs (Cont.)	115
Dep. (Cont.)	120
Bond Interest	130
Profit and Loss	140

You will note that accounts 1-39 represent those accounts known as the asset group—accounts 40-79 being the liability group—and accounts over 79 being profit and loss, or income and expense accounts. Accounts 1-79 are therefore balance sheets accounts while accounts over 79 are profit and loss statement accounts.

Reference System.—The subsidiary and control ledger are referenced to each other by means of the decimal system of account numbering. This means that any control account in the control ledger is the aggregate of that particular group of accounts in the subsidiary ledger. Take for instance, account No. 9, the accounts receivable control. The debit balance of this account at all times represents the total of debit balances in all nine-decimal accounts in the subsidiary file, which are the individual accounts with the various consumers.

In a similar manner the credit balance in account No. 20R, the reserve for depreciation, control, is the sum of the credit balances in accounts.

20R- 5—Reserve for Depreciation—Dams and Reservoirs
20R-10—Reserve for Depreciation—Vit. Clay Flow Lines
20R-15—Reserve for Depreciation—Cast Iron Flow Lines

and all other decimal subsidiary accounts whose number begins with 20R.

Ledger Function.—The function of the subsidiary ledger is, then, for example, the detailed records of cost, or the itemized fixed capital accounts; in fact, all itemized information that may be desired. It is to be seen, therefore, that there is no limit to the extent to which the subsidiary ledger may be developed, the only restriction being the minuteness of detail required for adequate information. It is obviously necessary, however, to debit or credit the control wherever any subsidiary account, which the control represents, is debited or credited, otherwise the balance of the control account would not represent the sum of the balances of its subsidiary accounts. This necessitates that all journals be three column sheets, two columns for regular debit and credit items, and the extra column being used for detailed charges to the subsidiary ledger.

Control Ledger.—The function of the control ledger, on the other hand, is to afford at a glance complete information as to the financial status of the business as a whole, at any date.

Let us see, now, just what information we can obtain from these records.

Turn to account No. 1, cash in bank, and balance the account.

This can be done in a few seconds time. We can then determine the total bank balance, or the amount in any particular fund; be it operating fund, depreciation fund, repair fund, amortization fund, interest fund or any other fund that has been reserved for some particular use.

Turn to account No. 9, the accounts receivable control. This tells us the

total of outstanding accounts. If we desire to ascertain just which of the consumers are in arrears the information is available by referring to the nine-point group of subsidiary accounts.

Inventory.—Turn to account No. 15, the stores inventory account. The balance here represents the total value of the stockroom supplies. If the value of some particular item of stores is desired, or the quantity on hand, the cost or rate of use, turn to that particular account in the fifteen-point group in the subsidiary ledger.

Turn to account No. 20, the fixed asset control. The debit balance here represents the original total fixed valuation. If we desire to know the extent that our assets have depreciated from this value, turn to No. 20R, the reserve for depreciation control. The credit balance there, deducted from the debit balance in account No. 20 gives us the present worth of our total fixed assets.

If similar information is desired on some particular group of the assets, office equipment, for instance, then find accounts No. 20-65 and No. 20R-65 in the subsidiary ledger. Account No. 20-65 shows us the orginal value set up; account No. 20R-65 the amount of deduction to arrive at the present depreciated value.

Vouchers Control.—In a similar manner, account No. 40, audited vouchers control, gives us the total of accounts payable; account No. 74 surplus, the present net worth of the department now or at any time past, and 140, profit and loss, the net profit or loss for any period of the past. In a like manner, every control account shows the aggregate information, which its corresponding subsidiary accounts itemize and verify.

Is it of any value to the mangement to have such information at its fingertips, so to speak, whenever it has need for it? Would it mean anything toward economy or efficiency of operation to have a record of several years' standing that would furnish you any and all financial information that you desire? Would a profit and loss statement—and balance sheet each month assist you in keeping in intimate touch with the trend of department financial affairs? I say, and I am sure you will agree, it would.

Monthly Statements.—The management at Eureka have such statements prepared for them at each regular monthly meeting, for the month preceding. These statements are identical in form to the statements of a large corporation, or of a bank, which are prepared for their board of directors. such a system, such statements, as these, speak a common language that any competent bookkeeper, accountant, auditor, or well financially-informed executive can understand. The monthly statements furnish a birds-eye view of the effect on the finances of the department of the past month's business, in such a way that casual examination by the executive detects unusual sources of expense, increases or decreases in revenue, and enables him to keep in intimate contact with the results of doing business, without devoting all of his time to that one particular phase of the business. Unusual fluctuation in any item of revenue, expense, fixed capital, etc., are easily subjected to verification and determination of detail by examination of the books. And when the final analysis is reached—I think that this is perhaps the most important function of the bookkeeper and his books; namely, to furnish the superintendent with the complete financial details of the business in as compact a manner as possible for his use in intelligent control of the department.

Meter Over-Registration

How Water Company Handles Complaints Described in January Journal American Water Works Association

By F. B. BEECH
Superintendent, Ohio Valley Water Co., McKees Rocks, Pa.

Shakespeare must have had a disgruntled water consumer in mind when he wrote "More water glideth by the mill than wots the miller of" and having no water meter he did not have to concern himself with quantity. The water works man of to-day is well aware of the passage of this unheeded water and the task of imparting his knowledge to an incredulous and oftentimes indignant customer, before a large and unsympathetic audience (waiting to pay bills), requires a great deal of tact as well as all the known virtues. In other words, he is sowing his seed on unbroken ground in a thunder storm. The ground is cultivated by some water companies by enclosing "water leak pamphlets" with all water bills and if these pamphlets were properly studied and understood, very few complaints would be received. The great trouble with pamphlets is that too many are received by the individual. He receives one with his gas bill, his electric light bill, his telephone bill and often with his milk, ice and bread bills. Personally I read none, excepting the water pamphlet, which is studied to pick out flaws. A full knowledge of the facts and personal contact, coupled with excellent judgment, are necessary to satisfy complainants.

Method of Demonstrating Waste.—A useful means of demonstrating quantity is a coin with $\frac{3}{32}$, $\frac{1}{16}$ and $\frac{1}{8}$-in. holes drilled though it and giving, under each opening, the gallons of water wasted in 24 hours at 40-lb. pressure amounting to about 180, 960 and 3800 gal., respectively. If it were not for the fact that 90 per cent of complaints are due to leaking toilets, it might be well to install three taps in a conspicuous place adjacent to where bills are paid, each tap placarded and running to waste at the aforementioned rate.

Where a Major Operation Was Required.—Usually sympathetic explanations are best, but occasionally the patient needs a major operation. For example, the water company received the following letter:

Gentlemen:
The enclosed 2 bills are extremely high. Could you not please investigate and reduce same? You can see for yourself that such large amounts are grossly exorbitant.

The reply was:

Dear Sir:
In reply to your complaint of exorbitant water bills, we find that each quarter you complain of high bills, but your complaint is not entered until bills are at least two months overdue and shut-off notice has been served upon you.
There is no mystery about the high bills and we have frequently pointed out the cause. The fault lies in poor piping and water fixtures, together with careless tenants, factors over which the Water Company has no control.
Instead of shutting off water to-day (as per our notice) we are extending the time until Wednesday, September 15th, and trust we shall receive your remittance before that date.

How the Complaint Is Handled.—The complaint having been made, the bill is lifted and marked "to be re-read." An inspector takes the bill, re-reads meter, entering date and reading on the bill, at the same time inspecting meter especially as to whether or not the register bands (straight reading meter) are shrunk by hot water or fire, also listening on water line for running water. The rate per day at which meter is running can then be determined up to time complained of and also from that time to the date of re-reading of meter. These facts are aids to arriving at a conclusion. If customer has a just complaint, a corrected bill is rendered. If the account is correct, the original bill is returned to customer with the notation in red, "Inspected and found correct."

We check for leaks by listening on water line and observing meter while all fixtures are closed and by making sure the toilet is not leaking at overflow, the discharge, or by reason of cracked overflow pipe. We also make certain that there is no intermittent leakage on account of flush ball not seating properly or by the float ball scraping against the side of tank.

Testing Meters.—As a final resort, consumer is referred to the following printed rule:

Should any consumer of the water company at any time doubt the correctness of the meter measuring his service, he may, on application to the water company and the deposit of two dollars to defray the cost, have said meter tested, and should said test show the meter in question to be correct within 3 per cent he shall bear the cost of said test. On the other hand, should the test show the meter to be registering incorrectly beyond 3 per cent of the accurate amount, said deposit of two dollars shall be refunded and the account adjusted accordingly and the entire cost of the test shall be borne by the water company.

Snow Removal at Toronto

Methods Described in Paper Before International Association of Street Sanitation Officials

By GEO. W. DIES
Street Commissioner, Toronto, Ont.

TORONTO'S climatic conditions are similar to those of the majority of cities in New York state and the Northern states. We have no long spells of severe weather, as is generally supposed by our neighbors in the south.

Our winter season's set in round the latter part of December and break up in March. We are usually well advanced in our spring cleaning by the first week in April. The total snow fall during the winter season of 1926-1927, amounted to 45.5 in. The maximum fall at one time amounted to 5.9 in., while the mean temperature for the three winter months, January, February and March, was 21.3°, 27°, and 35.2° respectively.

Toronto covers an area of 32.32 square miles, with 562 miles of streets, 147 miles of lanes, and a population of 560,000, as returned by the Assessors. The street railway system is owned and operated by the city, and has a single track mileage of 197 miles.

Organization Principal Factor.—Organization is the principal factor in the effective and economical removal of snow. The first step each fall is the preparation of a map defining each district, location of foremen and disposal points. The patrolmen are organized in small gangs under the supervision of a sub-foreman. Additional casual labor is engaged as conditions warrant it.

Each foreman is responsible for his district. He has his men placed in gangs of 12 to 15, stationed at given points, and all working in the same direction. First attention is given to the business section and main car lines, crossings for pedestrians, and car stops, while the opening of channels in the vicinity of culverts is performed by small gangs working in defined areas.

The snow plow is used most advantageously for drifts and windroving the snow to each side of the roadway, thus permitting the teams and trucks to be loaded as quickly as possible.

Clearing Car Line Streets.—On car line streets the Transportation Commission operate snow plows mounted on flat cars, followed by rotary broom sweepers, all of which are equipped with steel blades, mounted upon swinging arms, which push the snow 8 to 10 ft. from the track allowance into a windrow. The congestion and parking of motor vehicles is perhaps the greatest handicap in the performance of the work, while it must be borne in mind that it is also the primary motive for the removal of the snow.

The commercial and flexible utility of the motor vehicle today demands that street officials place snow removal among the essential civic services and give it considerably more thought than it was given 12 to 15 years ago, when snow cleaning was confined to a very limited downtown area.

The most effective solution for fighting a snow storm is to work with the storm, in this way the snow does not become packed too firmly to be easily handled and guards against the danger of blocking traffic.

Disposal of Snow.—The disposal plays an important part in the economical removal of snow. Long hauls necessarily reduce the loading time. Therefore, sewer man-holes are utilized where possible. The construction of special snow holes at convenient locations has greatly relieved the situation, owing to the greater capacity of the hole and the fact that the disposition of the snow is accelerated by a flow of water from a water main.

The depositing of snow upon vacant lands, ravines, or park areas is found necessary at times, but has the objectionable feature of an unsightly dump until late in the spring before the last of the snow disappears.

Financing Snow Removal Work.—Snow removal work is financed by general taxation, and is included in the Department's Annual appropriation. The city does not remove the snow from sidewalks in front of private properties, but will upon request, the cost of which is chargeable to the property owner and included in the annual tax bill. The street railway system, while being owned by the city, pays 30% of the cost of removing snow from the car and bus lines, and in addition maintains its own gangs for switches, loops and yards.

Standardization of County Road Building Methods.—Thomas J. Wasser, president of the County Officials Division of the American Road Builders' Association, has invited all county highway officials of the nation to join in a movement for the standardization of county road building methods. The standardization will be accomplished through committees selected from the membership of the division. The next meeting will be held May 11, in Washington, D. C.

Chicago Tries Diesel Engine on Mixer

How to prevent employees from filling the gas tanks of their private flivvers from the company fuel supply and the gasoline tank of the concrete mixer, is a problem that has puzzled more than one contractor. Apparently the general average is that for every gallon used by the mixer there is at least one gallon and sometimes two which gets "lost" before it reaches the carburetor.

An unexpected solution of this difficulty was recently obtained by engineers of the city of Chicago during some experimental work in which Diesel engine power has been tried out on small mixers. Since the Diesel engine operates on fuel oil or kerosene the problem of stolen gasoline has been practically solved, and what appear to be decided advantages of simplicity of operation have been obtained.

About 18 months ago Jas. J. Versluis, engineer in charge of water works construction for the city of Chicago, conceived the idea of using Diesel engines on small mixers and as a test job a Marsh-Capron 7-S portable mixer was purchased without power plant and fitted in the city shops with a 6 horsepower, one cylinder Hill Diesel engine.

During the past year and a half this piece of equipment has been in continuous use on sidewalk, foundation and other general work for the city and has given such satisfactory results that similar engines are being installed on several new pieces of equipment, including a 10-S mixer.

Outside of the fact that a considerable saving on fuel costs has been effected, as the kerosene used does not interest gasoline thieves, the Chicago engineers have become convinced that due to its reliability, simplicity and ease of operation the one cylinder Diesel engine is a worthwhile power plant.

No difficulty has been experienced in starting on the fuel on which the power plant runs even in cold weather, it is said, and the engine has been found to start as easy or easier than gasoline engines under all conditions. The mixer has been used throughout the test in the normal way and without special attention. For the most part Foreman F. L. Courtney has left the handling of the engine entirely to the laborers employed on the job and there has not been the slightest trouble. The starting procedure is simple. All that is necessary is to open the fuel valve, release the compression and crank the engine. The compression is then thrown back on and the engine begins to fire.

The cost of the mixer equipped with the single cylinder Diesel runs from somewhat higher than the cost of the same mixer with standard gasoline equipment.

Reservoir Covering Pays Dividends

Reservoir Covering Pays Dividends, Experiences of Edwardsville Water Co., Edwardsville, Ill.

By C. W. KLASSEN and H. F. FERGUSON

Assistant Engineer and Chief Engineer, Division of Sanitary Engineering, Illinois State Department of Public Health

THE Edwardsville Water Company, which furnishes the public water supply for Edwardsville, Ill., recently covered an open storage reservoir at the suggestion of the Division of Engineering of the State Department of Public Health and thereby made a net annual saving of $61.50. This is a small saving, but it is a saving, and the cleaner, safer and otherwise improved quality of the water and resulting satisfaction among consumers, represents a value to the company far exceeding the cash saving.

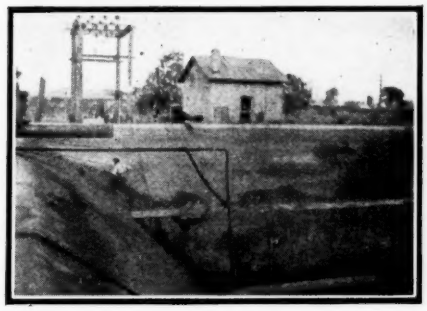
The Edwardsville supply is pumped from wells into a concrete collecting or storage reservoir. The reservoir, 70 ft. square at the top, has hopper sloped sides, is 40 ft. square at the bottom, 10 ft. deep and has a capacity of 250,000 gal. A wall through the center permits cleaning of one-half at a time.

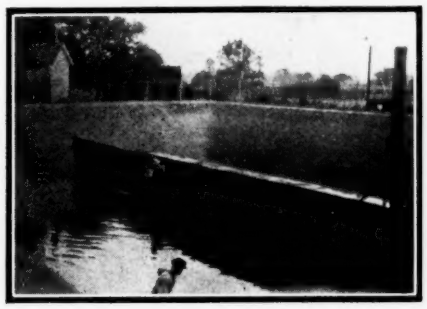
Conditions Before Reservoir Was Covered.—Before the reservoir was covered, a luxuriant growth of algae necessitated cleaning it twice monthly. Copper sulphate treatment suggested by us was partially successful, but the algae growth was still sufficient to impart objectionable tastes which were often complained of by the consumers and the treatment was somewhat of a nuisance. The uncovered reservoir also subjected the entire public supply to contamination by dust, dirt, insects, animal pollution, etc., and contamination introduced by workmen during the frequent cleanings. The cleaning operations not only introduced contamination, but also caused inconvenience and interruptions and because of reduced storage, a fire hazard.

Figures covering several years' operation with the open reservoir show that approximately $175 was spent annually trying to keep the reservoir clear and free from algae growths. This figure includes the labor and copper sulphate treatment.

For several years the Engineering Division of the State Department of Public Health recommended that the reservoir be covered, and following a change in ownership, this improvement was made in May, 1927. The cover is a tight, substantial plank and tar paper roof, supported on a steel frame, erected at a total cost of $1,500.

Two financial comparisons of the reservoir covered and uncovered will be made, (1) by comparing the total capitalized cost in each case, and (2) by comparing the annual expense before and after covering.





Views of Reservoir of Edwardsville Water Co., at Edwardsville, Ill., Before It Was Covered

Total Capitalized Cost Comparison.—The cost in terms of capital is equal to the first cost, plus the annual cost of operation and maintenance capitalized at the current rate of interest, plus the capital necessary to add to make good the depreciation, that is, to provide such a sum which when put at the current rate of interest will be sufficient to renew the structure at the expiration of its life. Expressed as in "Public Water Supplies," by Turneaure & Russel:

$$S = C + \frac{O}{r} + \frac{C}{(1+r)^n - 1}$$

where: S=total capitalized cost
C=first cost of cover
O=annual cost of operation and maintenance
r=current rate of interest
n=life of structure

With the reservoir uncovered, C (first cost of cover) and $\frac{C}{(1+r)^n-1}$ (capital necessary for depreciation) are zero and only the operating cost of $175 for cleaning need be considered. Taking the current rate of interest as 5 per cent in all calculations, the total capitalized cost is

$$S = O + \frac{175}{.05} + O = \$3,500$$

With the reservoir covered C is $1,500, the operating cost zero and the depreciation item (for cover only) is divided into three parts, namely the depreciation on (1) the roofing material, (2) the plank roof, and (3) the steel frame. It was assumed that the tar roofing paper would be replaced every 10 years at a cost of $200, the plank roof every 20 years at $500 and the structure (including the tar paper and plank every fifty years at $1,500. It was also assumed that the reservoir would be cleaned every 10 years at a cost of $10. This amount not being an annual maintenance expense, should be included in "depreciation," because it is necessary to maintain enough capital to care for the $10 expense every 10 years. The total capitalize cost for the covered reservoir would then be:

$$S = 1500 + O + \frac{200}{(1.05)^{10}-1} + \frac{500}{(1.05)^{20}-1} + \frac{1500}{(1.05)^{50}-1} + \frac{10}{(1.05)^{10}-1} = \$2,270$$

where: 1500=capital necessary for first cost
0=capital necessary for annual maintenance
$\frac{200}{(1+.05)^{10}-1}$=capital necessary for depreciation on tar paper
$\frac{500}{(1+.05)^{20}-1}$=capital necessary for depreciation of plank roof
$\frac{1500}{(1+.05)^{50}-1}$=capital necessary for depreciation on steel frame
$\frac{10}{(1+.05)^{10}-1}$=capital necessary for cleaning every 10 yrs.

Comparing the capitalized cost of $3,500 for the reservoir uncovered to the $2,270 covered, a capital saving of $1,230 is obtained. This amount at 5 per cent interest gives an annual saving of $61.50 with the reservoir covered.

Annual Expense Comparison.—The

annual expense of the uncovered and covered reservoir by this method is equal to the sum of (1) the interest on the first cost, (2) the annual cost of operation and (3) the annual depreciation or the annual payment necessary if placed at compound interest to accumulate in the life of the structure an amount equal to the cost for renewal, or:

$$\text{Annual expense} = Cr + O + \frac{Cr}{(1+r)^n - 1}$$

where: C=first cost of cover
r=rate of interest
O=operating expense
n=life of structure

The annual expense of the uncovered reservoir is simply the annual operating expense of $175, for there is no first cost and hence no depreciation of cover.

The annual expense of the covered reservoir is (1) the first cost, $1,500, times the rate of interest, 5 per cent, plus (2) the operating expense which is zero, plus (3) the annual depreciation which is taken in three parts as in the capitalized cost method, plus (4) the expense of cleaning every 10 years.

$$\text{Annual expense} = 1500 \times .05 + O + \frac{200 \times .05}{(1.05)^{10} - 1} + \frac{500 \times .05}{(1.05)^{20} - 1} + \frac{1500 \times .05}{(1.05)^{50} - 1} + \frac{10 \times .05}{(1.05)^{10} - 1} = \$113.50$$

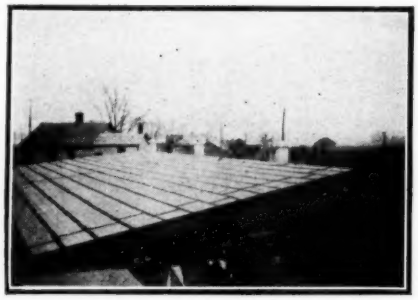
where: $1500 \times .05$=first cost of cover × annual rate of interest
O=annual operating cost
$\frac{200 \times .05}{(1.05)^{10} - 1}$=annual depreciation on tar paper life 10 years
$\frac{500 \times .05}{(1.05)^{20} - 1}$=annual depreciation on plank roof life 20 years
$\frac{1500 \times .05}{(1.05)^{50} - 1}$=annual depreciation on steel frame life 50 years

Comparing the annual cost of $175 without cover to $113.50 with cover, an annual saving of $61.50 is obtained, which corresponds to the saving figured by the capitalized cost method.

Analyses Before and After Covering.—All persons interested in supplying water to the public realize the value of a clear, clean water free from objectionable odors, tastes and possibilities of pollution. According to A. P. Harris, manager of the water company, no complaints regarding objectionable tastes or odors have been received and no algae noticed since the reservoir was covered.

Analyses of samples (Table I) collected before and after the covering of reservoir also show the improvement made by the cover.

The wells both before and after the covering of the reservoir yielded a water which conformed to the U. S. Public Health Service standards, but



View of Reservoir After Covering

exposure in the open reservoir changed the quality so as to bring it outside these standards, which allow 10 per cent of the 10 c.c. portions analyzed to be positive (and formerly a bacterial count of 100 per c.c.). The limited number of samples (nine) analyzed since the reservoir was covered show that the tap water now meets the U. S. Public Health Service standards.

Acknowledgment.—The above paper was presented March 29 at the 20th annual meeting of the Illinois Section of the American Waters Works Association.

Second Annual Meeting, Florida Section, American Water Works Association

The second annual meeting of the Florida Section of the American Water Works Association was held at Orlando, Fla., April 3 and 4.

The meeting opened at the Tuesday luncheon, which was the courtesy of the Orlando Chamber of Commerce, at which time 65 plates were served. In the afternoon the business session was held and the following officers were elected for the ensuing year: Chairman, A. F. Michaels, of Orlando; vice-chairman, R. W. Reynolds, West Palm Beach. Directors: C. C. Brown, Gainesville; F. J. Stewart, Hollywood; F. W. Lane, St. Petersburg; Ben Tippens, Daytona Beach, and O. Z. Tyler, Jacksonville. Secretary-treasurer, E. L. Filby, Jacksonville.

The Tuesday evening banquet was given in honor of J. E. Gibson, president American Water Works Association. Mr. Gibson gave a very pertinent address on the subject of "Not Good If Detached"—stressing the fact that every water works superintendent or operator should be a member of the Section of American Water Works nearest to him. Speakers at this banquet included, Malcolm Pirnie, Consulting Engineer of New York City, and F. W. Weir, Assistant Engineer of Georgia State Board of Health.

The Wednesday program was given absolutely according to the schedule on program. By Wednesday noon the register had reached its peak of 114 and an enjoyable luncheon was served at the Orlando Utilities Commission Filter Plant (municipal) through the courtesy of the Utilities Commission.

At the manufacturers' banquet on Wednesday evening Jacksonville was selected for the next meeting place for the 1929 meeting.

Stenographic notes were taken of the entire meeting for the two days.

Among those present were:

J. E. Gibson, President, American Water Works Association, Charleston, S. C.

Anson Squires, former Superintendent Water Works, Tampa.

Herman Gunter, State Geologist, Tallahassee.

F. W. Weir, State Board of Health, Georgia, Atlanta.

Malcolm Pirnie, Consulting Engineer, New York City.

A. P. Black, Chemist, University of Flordia, Gainesville.

F. R. Georgia, Chemist, Rollins College, Winter Park.

F. W. Lane, Superintendent Water Works, St. Petersburg, Fla.

A. C. Gray, Gray Artesian Well Co., St. Augustine, Fla.

W. K. Seitz, City Manager, Melbourne, Fla.

C. H. Cairnes, City Manager, Sanford, Fla.

Chowning Cawthorn, City Manager, Palatka, Fla.

Jess Ferrell, City Manager, Haines City, Fla.

C. E. Royland, Commissioner of Water Works Department, Sarasota, Fla.

H. G. Warner, Purity Springs Water Co., Tampa, Fla.

Frank Schwabel, Superintendent Water Works, Clearwater.

O. Z. Tyler, Superintendent Water Works, Jacksonville, Fla.

W. H. Hobbs, Florida East Coast Railway, St. Augustine.

H. C. Koelz, Assistant Engineer, Atlantic Coast Line Railway.

Table I

	Before Covering			After Covering		
	From wells	From Res. & dus. system	Last nine samples	From wells	From Res. & dist. system	First nine samples
No. 10 c. c. portions analyzed	217	6052	45	5	198	45
Per cent positive	1	.21	13.	0	6.	7
Av. bacterial count	11	129	19	2	76	22

Litigation Due to Water Leaks

Experiences in Law Suits in Massachusetts Outlined in Paper Presented Before New England Water Works Association

By GEORGE H. FINNERAN
Superintendent Water Service, Boston., Mass.

Litigation is increasing steadily. It is epidemic. One person learns from another what to do and how to do it. The courts are choked with civil actions. Lawyers are multiplying in number. The public is getting keener and keener for the dollar. The desire for easy money is gaining strength. So, when some people think they have the slightest opportunity to secure damages they lose no time in starting action. That they are not always successful does not deter them. The City of Boston employs a force of twelve lawyers to combat the claims and suits for alleged damages. There is also a Committee of Claims composed of members of the City Council who consider and pass on claims under $500. The Police Department does some preliminary investigation in all claims under $500.

Investigation for Water Service Claims.—The Water Service has one man who devotes his entire time to investigating claims and examining all premises where water has entered or where there is any possible chance that a claim will be made. The work of this man is valuable inasmuch as he is on the ground while the matter is fresh and gets his facts at first hand and by direct observation. Shortly after a leak or break of any consequence has occurred this man is notified, and he makes a personal examination of the premises affected and lists all property that may be involved in a future claim. This is a check on the inflation of an inventory of damaged goods presented by the plaintiff at a trial held perhaps several years later when memories are dim and important witnesses are absent or dead.

The total amount paid by the Water Service of Boston in settlement of claims for damages and awards by judge and jury during the last six years was $100,220.44 or an average of $16,703.40 each year.

To give an example of the amount of unwarranted damages asked for by claimants, the records of the city of Boston, for a certain period, show a total of $470,300 ad damnum or amount sued for, and a total of $26,715 actually awarded. That is equivalent to a 5.7 per cent recovery or about 1/18 the amount which claimants considered they were entitled to.

The amount of money which this litigation runs into yearly emphasizes the necessity for preventing, as far as possible, the occurrence of leaks and breaks and of minimizing the damage resulting from the same by quick and efficient action in stopping the flow once started, by energetic work in removing water from the flooded premises, by performing salvage work and assisting within proper limits in getting the interrupted business or service back on a working basis as quickly as possible and by effectively opposing any attempt on the part of the plaintiff to collect unreasonable or unwarranted damages.

How the Boston Department Protects Itself.—The Boston Department protects itself to a certain extent by stipulating in an application made by an owner for a fire pipe that the City will not be liable for damage resulting from a leak or break in the pipe. The legal basis for a stipulation of this sort is the fact that no revenue is derived from water furnished for fire protection and that the extinguishing of fires is a governmental function. The application has the force of a contract, and the immunity of the City has been upheld by the courts.

Likewise, damage from a broken water main, if the main is used exclusively to furnish water for fire protection, cannot be recovered for the same reason, namely, that fire extinguishing is a governmental function.

While a hydrant is supposedly a fire-fighting fixture, it is usually so involved with the business of supplying water for domestic purposes, for which a revenue is received, that the courts do not free it from liability. A hydrant, unless it is connected with a strictly high pressure fire service main, is usually connected with a main that supplies water for domestic purposes. It has also become the source of supply for contractors engaged in construction work and thus becomes a medium of revenue.

Damages due to leaking or defective service pipes, or to the mains that supply them, are recoverable under certain conditions because of the revenue factor.

The following excerpts and citations from records of Massachusetts court cases will give an idea as to the legal liability of municipally or privately owned water systems for damages or breach of contract:—

City's Liability.—The City of Boston having voluntarily entered into a commercial enterprise for the purpose of supplying its inhabitants with water is to be regarded as a private corporation, and it is liable for personal injuries or property damage caused by reason of the negligence of its officers, agents, or employees, engaged in the construction, operation, or maintenance of its system of water works.

The obligation of the City is, not to insure the inhabitants against injury or damages, but it must exercise reasonable care and vigilance in the construction and operation of its works.

McLaughlin v. City of Boston. Pipe frozen by removal of ordinary protection by one Barry in laying a sewer. Only one foot of cover over water pipe.

Liability of City for Negligence of Water Department.—A city in carrying on its water department is engaged in a work voluntarily undertaken by it, partly commercial in character, and for which it receives pay from those making use of the water, and is quoad hoc (to this extent) to be regarded as a private corporation. The city is thus liable for personal injuries caused by the negligence of its officers, agents, or employees, while engaged in the construction and operation of its system of water works. White v. Board of Health, L. R. 10 Q. B. 219. Scott v. Manchester, 1 H. & N. 59. Wilson v. Underhill, 108 Mass. 361 Fox v. Chelsea, 171 Mass. 297. Lynch v. Springfield, 174 Mass. 430.

Municipality Liable Like Private Corporation in Constructing and Maintaining Water Supply System.—Where a city or town has been authorized by a special statute to construct and receive profits from a water supply system, and has voluntarily accepted the same, it is just as liable as is a private corporation or an individual for negligence in the manner of construction of its works by which injury or damage is caused to person or property. Hand v. Brookline, 126 Mass. 324.

A city is liable to travellers who are injured by reason of the negligent laying and maintaining of pipes or hydrants in the streets or highway. Hand v. Brookline, 126 Mass. 324.

City Liable on Same Grounds as Private Corporation.—A city voluntarily maintaining a water system and receiving pay from the takers of water is engaged in a commercial business and with reference to the distribution of water is to be regarded as a private corporation. It is liable, therefore, for personal injuries caused by the negligence of its officers, agents, or employees, while engaged in the construction and operation of its system of water works. White v. Board of Health, L. R. 10 Q. B. 219. Scott v. Manchester, 1 H. & N. 59. Wilson v. Underhill, 108 Mass. 361. McAvoy v. New York, 54 How. Pr. 245. Bailey v. New York, 3 Hill, 531. Estberg, etc. v. Portland, 34 Oregon, 282.

City Liable Only for Reasonable Care and Vigilance in Construction and Operation of Works.—If due diligence is used in laying and maintaining the pipes no one can be held liable for their breaking. Nor is the liability of the city such as to insure the citizens against personal injury or damage to his property. The city is liable when it fails to exercise reasonable care and vigilance in the construction and operation of its works. Ring v. Cohoes, 77 N. Y. 83. Hunt v. New York, 109 N. Y. 134. Jenney v. Brooklyn, 120 N. Y. 164, Terry v. New York, 8 BOSW. 504. Green v. Chelsea, etc. 70 L. T. NS. 547.

Liable for Negligence.—A city may be held for negligence in the construction of water works or the laying of water pipes. Lynch v. Sprinfield, 174 Mass. 340. Fox v. Chelsea, 171 Mass. 297. Stoddard v. Winchester, 157 Mass. 567.

Liability of a Water Company for Accident Due to Negligent Construction or Improper Location of Water Fixtures and for Damage Resulting from the Bursting of an Underground Pipe. When a water company complies strictly with the statutes or ordinances regulating its fixtures and permanent apparatus in the streets, and keeps such fixtures in good repair; it is not liable for accidents to passers-by; but the company is liable for any accident due to the negligent construction or improper location of such fixtures. So also as to underground pipes, the company cannot be held liable for damage resulting from the bursting or leaking thereof, unless the pipe was negligently constructed or laid or the company has negligently failed to make repairs, the necessity of which has been brought to its notice, but in case of such negligence the company, of course, is liable.

Actions.—The complaint in an action based on the negligence of a water company must

show the existence of such negligence, and that it was the proximate cause of the injury complained of. Plaintiff has the burden of proof as to matters necessary to his recovery, and, if there is a substantial variance between his complaint and the proof adduced in support thereof, he cannot recover. The usual rules of practice govern as to the effect of evidence and the propriety of instruction. When the facts are controverted, the question of defendant's negligence is for the jury, who must also decide whether such negligence was the cause of the injury, or, when the action is based on contract, whether the alleged contract existed. Damages proportionate to the injury suffered by plaintiff should be awarded; but where the suit is by a municipal corporation, damages suffered by individuals by reason of the failure to furnish the stipulated quantity of water cannot be taken into account.

Leak in Water Pipe Undermining the Highway.—Hand v. Brookline, 126 Mass. 324. The plaintiff, while travelling with due care in a wagon upon the highway, was injured by reason of his horse suddenly breaking through the surface of the highway. The declaration contained two counts.

1. Under the statutes alleging a defect in the way which the town was bound to keep in repair.

2. At common law for neglect in construction of water pipes whereby the water escaped and undermined and washed away the earth under the highway.

The plaintiff and court agreed that the first count could not be maintained and went to the jury on the second count. The jury found a verdict for the plaintiff.

Held, that on the evidence he could not recover on the first count, but that he could on the second.

Inasmuch as the evidence was conflicting as to the negligence on the defendant's part as to the original construction of the water pipe, the case was rightly submitted to the jury.

Judge Gray stated in the case:

"The right of action against a city or town for a defect in a highway is, as has been repeatedly affirmed by this court created and limited by the statutes. Gen. Sts. C. 44, S. 22. But those statutes do not affect the common law liability of owners of aqueducts for damages caused by negligence in their construction. If the water works under the highway in Brookline had been constructed by an aqueduct corporation or by the City of Boston under authority of the Legislature, and for the purpose of supplying water at certain rates or rents, the corporation or the city would clearly be liable in an action like this; and the Town of Brookline is not the less liable for any injury resulting from a neglect in the construction of its water works because it happens to be also the town in which the highway is situated and which is bound by general statutes to keep the highway in repair."

Shut-off Box May Be a Defect.—Redford v. Woburn, 176 Mass. 520. The plaintiff stumbled over a water shut-off box in the middle of a sidewalk and was injured. The box projected above the surrounding gravel ⅛ in. on one side—¼ in. on another side—and 1½ in. on a third side.

Held, that the jury might be warranted in finding the shut-off box to be a defect.

Judge Morton said: "The fact that the shut-off was the usual contrivance used in cities for the purpose for which it was placed in the sidewalk would not justify the defendent in maintaining it in such a condition as to render the highway defective and unsafe.

We do not think it could be ruled as a matter of law that the jury was not warranted in finding that a shut-off box in the middle of a sidewalk much used for foot travel projecting on one side an inch and a quarter above the surrounding gravel, did not constitute a defect. Whether such an object was liable to cause travellers, while in the exercise of due care, to stumble and fall, or to turn or sprain the ankle as we infer the plaintiff did, and whether the defendant exercised reasonable care in suffering the box and sidewalk to remain in the condition in which they were in, seems to us questions for the jury."

Judge Lathrop in the case of O'Brien v. Woburn, 184 Mass. 598, said: "The plaintiff stumbled over a water shut-off in the sidewalk of Green Street in the defendant city, fell and sustained personal injuries for which she seeks to recover damages in this action. The shut-off was in a travelled part of the sidewalk and extended above the surface thereof, according to some of the witnesses from a half inch on one side to an inch and a quarter on the other side, and according to eye witnesses it so extended an inch and a half on one side and two inches on the other. It is not controverted that it was competent for the jury to find that this was a defect."

Liability of a Town for Damage to Plaintiff's Property Caused by an Overflow from a Standpipe Maintained by the Defendant.—Kelly v. Winthrop, 219 Mass. 471. A town which maintains a standpipe that was built and is operated, not only for protection against fire, but also "to equalize the pressure in general for the domestic service" supplied by the town as a commercial enterprise for its own corporate benefit, is required in the maintenance and operation of the standpipe to use reasonable care to avoid injury to adjoining private property.

If a town maintains and operates a standpipe in part for the distribution of water as a corporate commercial enterprise, its liability for injury to adjoining private property, by reason of negligence in the maintenance or operation of the standpipe, is not affected by the fact that the water used in the standpipe is obtained from the Metropolitan System.

In an action against a town for damage to the plaintiff's property, caused by the overflow of a standpipe maintained and operated by the defendant in part for the distribution of water as a corporate commercial enterprise, it appeared that before the time of damage no overflow from the standpipe had occurred, that the overflow in question was due to the clogging of the regulating valves of the conduit of the Metropolitan Water System from which the defendant obtained the water that was used in the standpipe, that the defendant had no control over this valve, but that it had knowledge that if foreign substances, floating in the water, passed into the valve, it would cease to work automatically and would leak, causing the standpipe to overflow, and that, if an overflow pipe had been provided, as was possible, the water would have been discharged on the defendant's own land and the plaintiff's property would not have been damaged.

Held, that the jury was warranted in finding that the defendant reasonably ought to have anticipated and guarded against the condition that occurred and that its failure to do so was negligence for the consequences of which it was liable to the plaintiff.

Liability of Town for Failure to Supply Water Due to a Leak in Standpipe.—In the case of Watson v. Needham, 161 Mass. 404, it appeared at the trial of an action for breach of contract by a town to furnish a person with water for use in a boiler to make steam to heat his greenhouse that, in the regulations which were made part of the contract, the right was expressly reserved to shut off the water in cases when it becomes necessary to make extensions or repairs and whenever the commissioners deemed it expedient.

There was evidence tending to show that the damage to the plaintiff was not caused by the exercise of this reserved right, but by a leak which remained undiscovered until after the standpipe had been emptied and there was no longer any pressure in the service pipes, and the inference was warranted that due diligence was not used to discover such leaks quickly, to shut off the flow of water to the place of the leak and to start pumping engines so as to prevent the standpipe from being emptied.

Held, that the court might properly find a breach of contract.

Liability of City for Destruction of Plants in a Greenhouse Due to the Freezing of a Water Supply Pipe.—In Stock v. Boston, 149 Mass 410, it appears that the city, under contract with the owner of a greenhouse to supply him with water for steam heating and for his plants, in constructing a sewer in an adjacent street, caused the supply pipe to be uncovered and negligently exposed to the cold so that the water in the pipe was frozen and his supply cut off. The owner could not by the use of reasonable diligence obtain a supply of water or heat from other sources, and the plants were destroyed.

Held, that the exposure of the water pipe was the proximate cause of the injury; and that the city was liable to such owner in tort for such damage, even if he might recover the same damages in an action upon the contract.

In this same case Judge Morton said: "The defendant contends that the damages suffered by the plaintiff were too remote. The damage was caused, because the plaintiff, after the water was cut off, was unable to furnish water to his plants and to supply his boiler with water so as to heat the greenhouse."

In Derry v. Flitner, 118 Mass. 131, it is said: "One who commits a tortious act is liable for any injury which is the natural and probable consequence of his misconduct. He is liable not only for those injuries which are caused directly and immediately by his act, but also for such consequential injuries as, according to the common experience of men, are likely to result from his act. And he is not exonerated from liability by the fact that intervening events or agencies contribute to the injury. The true inquiry is whether the injury sustained was such as, according to common experience and the usual course of events, might reasonably be anticipated."

In the case at bar the natural consequences of the tortious acts of the defendant, in leaving the pipe exposed, were that the water in it froze, the supply of the plaintiff was cut off, his means of furnishing water to the plants and heat to his boiler were destroyed and his plants were killed. The jury have found that this happened without any negligence on the part of the plaintiff, and as he could not by the use of reasonable diligence obtain a supply of water or heat from other sources.

The case of Metallic Compression Casting Company v. Fitchburg Railroad, 109 Mass. 277, is similar to the case before us. There the defendant negligently ran a train over a line of hose belonging to a third party, which the plaintiff was using to extinguish a fire in its factory. It was held that the severing of the hose was the proximate cause of the destruction of the building and that the defendant was liable for its value. The instructions in this case were in accordance with the principles we have stated and were correct.

It is quite evident from the foregoing legal citations that it is good economic policy for a water department or company, in Massachusetts at least, to do all in its power to bring the condition of its reservoirs, dams, standpipes, pipe lines, service pipes, gates, hydrants, and other figtures and fittings to a high degree of safety, soundness, and efficiency, and, by constant vigilance and attention, to maintain them as such and not to leave itself open to the charge of negligence or lack of diligence in avoiding damage or breach of contract. It should be an ever present thought in the minds of those responsible that a leak or a break, large or small, a defective fixture or fitting, and a neglected weak spot or danger spot are potential court judgments requiring the payment of sums of money of varying amount.

To Take Inventory of Water Resources.—To aid in solving the problem of flood control, the American Engineering Council will urge Congress to authorize an inventory of the water resources of the United States under the direction of the Geological Survey, it is announced by the president of the council, Dean Dexter S. Kimball, of Cornell University.

Control of Salt Marsh Mosquitoes.—A survey of salt-mash mosquitoes conducted by the U. S. Public Health Service in cooperation with the U. S. Bureau of Entomology, showed that although there are nearly 6,000,000 acres of saltmarsh along the Atlantic and Gulf Coasts, the acreage requiring mosquito control can be expressed in tens of thousands.

California Water Works Men Meet in June.—The next meeting of the California Section of the American Water Works Association will be held at San Francisco, Calif., week of June 11th, 1928, in conjunction with the annual convention of the American Water Works Association. Wm. W. Hurlbut, 207 South Broadway, Los Angeles, Calif., is Secretary.

Reforestation of Water Reservoir Properties.—The Water Department of Akron, O., has begun the reforestation of its water supply reservoir properties.